TESTS WITH FIVE SILICA DUSTS AGAINST GERMAN COCKROACHES

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The recent work of Wagner and Ebeling (1959) has re-emphasized the insecticidal properties of silica dusts and has created interest in this type of control, particularly with certain household pests. These compounds affect insects by causing a water loss which eventually results in death (Wigglesworth 1957, Ebeling and Wagner 1959).

The effectiveness of CAB-O-SIL, Santocel-C, Estersil-1, SG-67, and SG-68 was determined in laboratory and field tests against the German cockroach, *Blattella germanica* (L.), in the Orlando, Florida, area. Estersil-1, a surface-esterfied amorphous silica, and SG-67, which has theoretically 4.7% of ammonium silicofluoride present as a monomolecular layer, are coated, finely divided silicas. Santocel-C and SG-68 are uncoated finely divided silicas. CAB-O-SIL is a silica smoke, produced by burning silicon tetrafluoride in a mixture of hydrogen and oxygen. The silica dusts were used at full strength and mixed with talc, individually and in combination with malathion. Malathion and Diazinon dust were used as standards.

LABORATORY TESTS

The dusts were applied to 5¼-inch-square plywood panels in a dust tower (Fig. 1). The tower consisted of a bell jar 14 inches high with an inside diameter of 8¼ inches. An inverted glass funnel was inserted from the inside of the bell jar through a one-hole stopper; the stem of the funnel projected 4 inches above the jar. A small rubber stopper tied to the out-

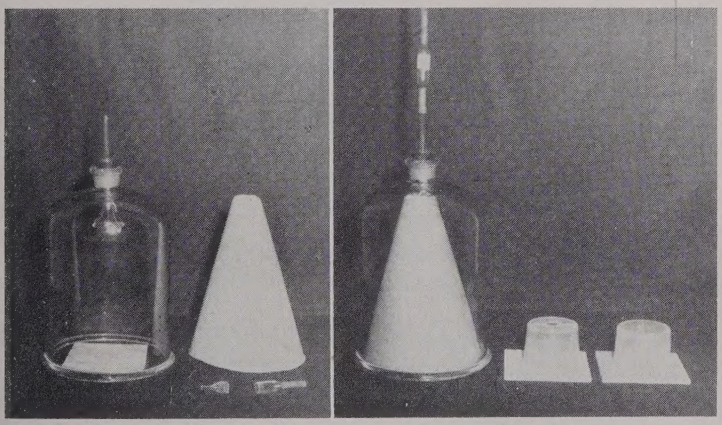

Figure 1. Unassembled and assembled components of the dust tower and the plastic dishes used for exposure of cockroaches to treated panels.

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side of the glass funnel was placed inside the cone to retain the silica dusts in the stem until ejection by compressed carbon dioxide.

A 15-ml., volumetric, transfer pipette, with both ends severed 2 cm. from the bulb, was cut across the bulb to provide two sections of unequal volume. The dust was weighed in the larger section. The two sections were rejoined with masking tape and one end was connected to the protruding funnel stem by a 1-inch piece of rubber tubing, and the other end was connected to a source of carbon dioxide under a pressure of 20 to 30 p.s.i. (gauge pressure), which was turned on for 0.4-0.6 second to expel the dust.

The interior shape of the dust chamber was modified by the addition of a glazed paper cone which extended from the funnel to the bottom perimeter of the bell jar. After ejection of the dust, the panel remained under the tower for 3 minutes, then the bell jar was cautiously removed to minimize air movement over the dusted surface. A plastic dish, 3½ inches in diameter, with a small opening in the bottom was coated with pyrophyllite and inverted over the panel (Fig. 1). The pyrophyllite coating forced the cockroaches to remain in contact with the treatment (or silica dust), since they cannot crawl on pyrophyllite-coated plastic.

Ten normal male cockroaches, which were 8 weeks old, were dropped through the dish opening onto the dusted surface. After exposure for 30 minutes, they were removed and placed in a Petri dish. Mortality counts were taken 48 hours later. The tests were conducted at 82°-86° F. and at a relative humidity of 50%-70%.

The full-strength silica dusts were tested at a range of dosages between 100 and 500 mg./sq. ft. The mortalities and dosages were plotted on log-probit paper and the LD-50's and LD-90's (mg./sq. ft.) were estimated as follows:

	LD-50	LD-90
Santocel-C	205	455
Estersil-1	175	375
CAB-O-SIL	100	240
SG-68	109	150
SG-67	104	130

At the LD-50 level CAB-O-SIL, SG-67, and SG-68 were approximately equal in effectiveness, but at the LD-90 level SG-67 and SG-68 were superior to the others.

Tests were also conducted to determine the effectiveness of talc formulations containing 2% of malathion in combination with 10% of Estersil-1, SG-67, or SG-68 in comparison with the individual materials. Since pilot tests indicated that maximum mortalities resulted when the dusts were mixed without a solvent, all the formulations were prepared in this manner. The results are given in table 1. The combinations of malathion and SG-67 or SG-68 were more effective than malathion alone, but the silica dusts alone at 10% were ineffective.

TABLE 1. SUSCEPTIBILITY OF MALE GERMAN COCKROACHES TO TALC CONTAINING SILICA DUSTS AND MALATHION, INDIVIDUALLY AND IN COMBINATION, APPLIED AT VARIOUS DOSAGES ON PLYWOOD PANELS (2 TO 8 REPLICATIONS).

Material	Dosage (mg./sq. ft.)	Percent knockdown and kill after 48 hours
Estersil-1, 10% + malathion, 2%	500	70
	1,000	100
SG-68, 10% + malathion, 2%	250	70
	500	100
	1,000	100
SG-67, 10% + malathion, 2%	250	53
	500	98
	1,000	100
Malathion, 2%	250	53
	500	87
	1,000	98
Estersil-1, 10%	500	5
	1,000	18
SG-68, 10%	250	13
	500	5
	1,000	28
SG-67, 10%	250	5
	500	3
	1,000	55

HOME TREATMENTS

Tests with Estersil-1, SG-67, and SG-68 were conducted against natural infestations of German cockroaches in homes. All treatments were made in a housing project consisting of ground-level units of five or six rooms. These units were similar in design and were constructed of concrete block. Pretreatment counts were made in the homes; all areas of cockroach infestation were noted and the percent reduction in live cockroaches was based on post-treatment counts throughout a period of 29 to 30 days.

The silica dusts and a standard dust containing 1% of Diazinon (*O,O*-diethyl *O*-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate) in pyrophyllite were applied with polyethylene squeeze-bottle dusters fitted with extension nozzles. These dusters require a minimum amount of air pressure, thereby preventing excessive floating of particles. Great care must be exercised in applying the silica dusts to prevent them from diffusing into parts of the home where they would be objectionable. Normally ⅛ to ¼ pound of dust was required to treat each unit. During the test period the temperature averaged 79.9° F. and the relative humidity 78.7%.

The results are shown in table 2. SG-67 was the most effective of the three silica dusts, but it was less effective than 1% Diazinon after 9-10 days.

Although the silica dusts gave some control, they were not only less effective than the Diazinon dust, but gave far less satisfactory results than oil sprays of the currently recommended organophosphorus insecticides, as tested under similar conditions by Lofgren et al. (1957).

TABLE 2. CONTROL OF GERMAN COCKROACHES IN HOMES WITH DIAZINON OR SILICA DUSTS (2 OR 3 REPLICATIONS).

Material	Pretreatment count	Percent reduction after indicated days— 1	2	5–6	9–10	12–13	16–17	22–23	29–30
Diazinon (1%)	463	93	92	94	95	92	97	94	91*
SG-67	82	86	94	95	86	83	87	62	69
SG-68	150	29	0	24	1	0	0	0	0
Estersil-1	283	82	80	80	78	72	80	68	60

* 77% after 90 days.

SUMMARY

Based on the LD-50's in laboratory tests, the silica dusts CAB-O-SIL, SG-67, and SG-68 were more effective than Estersil-1 or Santocel-C against male German cockroaches, *Blattella germanica* (L.). At the LD-90 level SG-67 and SG-68 were superior to the others.

Combinations of 10% of SG-67 or SG-68 and 2% malathion in talc were more effective than 2% of malathion alone, but 10% of the silica dusts alone were ineffective.

The control of German cockroaches in homes ranged from 29% to zero percent for 30 days with SG-68, from 82% to 60% with Estersil-1, from 95% to 62% with SG-67, and from 95% to 91% with 1% Diazinon.

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GROUND BEETLES ON COTTON FOLIAGE[1]

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The role of species of the carabid genus *Lebia* as predators of cotton insects has received little attention. Five species of the genus *Lebia* of the family Carabidae were found on cotton foliage in Arkansas during 1957, 1958, and 1959. They ranged over the entire plant, tending to concentrate in the terminals.

A number of species of these small ground beetles are active on the leaves and stems of various herbaceous plants. Several species have been found to be predaceous on both adult and immature stages of economic pests. Glover and Riley (Riley, 1871) observed that *Lebia grandis* Hentz. fed on both eggs and larvae of the Colorado potato beetle. Cushman and Isely (1916) reported *Lebia ornata* Say feeding on both larvae and adults of the cherry leaf beetle, *Galerucella cavicollis* (Lec.). *Lebia viridis* Say was observed by D. Isely (1920) to feed on eggs, larvae, and pupae of the grape flea beetle, *Altica chalybea* (Ill.). Silvestri (Clausen, 1940) found that *Lebia scapularis* Fourc. fed on all stages of an elm leaf beetle, *Galerucella luteola* Mull.

TABLE 1. NUMBER OF *Heliothis zea* EGGS CONSUMED BY ADULTS OF *Lebia analis*.

Specimen	No. of days	Total no. of eggs consumed	Av. no. of eggs consumed per day
1	18	71	4
2	21	128	6
3	21	138	6.5
4	8	30	3.7
5	18	131	7.3
6	18	130	7.2
7	13	82	6.3
8	14	83	6.0
9	18	128	7.1
10	13	81	6.2
		Average consumed per day by all specimens	6.03

The 5 species found on cotton in Arkansas have been identified[4] as *Lebia marginicollis* Dej., *L. pumila* Dej., *L. abdominalis* (Chaud.), *L. viridis* Say, and *L. analis* Dej. *L. viridis*, *L. pumila*, *L. marginicollis*, and *L. ab-*

[1] Published with approval of Director of the Arkansas Agricultural Experiment Station.

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[4] Specimens identified by H. Dietrich of Cornell University.

dominalis were taken near Morrilton, Conway County, in cotton. *L. analis* was taken near Morrilton, Warren, Hope, Kelso, Altheimer, and Atkins in cotton, indicating a state-wide distribution in that crop. *L. analis* was particularly abundant in cotton during 1959. As many as 17 beetles to 100 terminals was not uncommon. Except for *L. abdominalis* and *L. pumila*, these species were also found on corn, alfalfa, and soybeans. *L. abdominalis* was found only on cotton and soybeans. *L. pumila* was found only on cotton.

It is possible that *Lebia analis* is, at times, an important bollworm egg predator on cotton. Attempts at field observations of feeding habits were unsuccessful. In the laboratory, *L. analis* fed freely on eggs of *Heliothis zea* (Boddie) but rejected tarnished plant bugs and aphids. Over a 1 to 3 week period, 10 individuals consumed an average of 6 *H. zea* eggs per day. First instar *H. zea* larvae were also eaten. *L. viridis* consumed *H. zea* eggs somewhat less freely.

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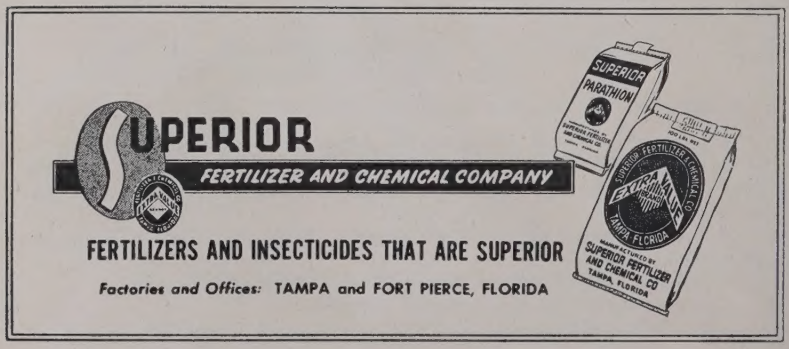

A LEAF SKELETONIZER, *LOBESIA LIRIODENDRANA* (KEARFOTT), OLETHREUTIDAE, ON *MAGNOLIA GRANDIFLORA* IN FLORIDA

ALVAH PETERSON [1]

On April 20, 1959, Mr. H. A. Denmark called the author's attention to the presence of a leaf skeletonizer producing considerable damage on two medium-sized trees of *Magnolia grandiflora* located on the University of Florida campus at Gainesville. The following are observations recorded on the biology of the insect and the type and extent of damage produced during 1959 and the spring of 1960.

DETERMINATION OF SPECIES: Infested leaves, possessing larvae and pupae in cocoons, were collected on April 20, 1959, and moths emerged on May 2, 1959. These were sent to Mr. C. P. Kimball for determination. He identified the moths to be *Lobesia liriodendrana* (Kearfott), a species of Olethreutidae. This insect was originally described from adults reared from larvae on *Magnolia virginiana.*

FOLIAGE INJURY: A single larva may produce a conspicuous, brown to silvery, elongated, irregular blotch on one half of a mature leaf which is more or less parallel with the midvein. The silvery blotch is the unbroken upper membrane of the leaf which the larva did not injure when it consumed the tissue on the lower surface. If two more or less parallel blotches occur on the upper surface, one on each side of the midvein, they were produced by two larvae, each living under its own web on one half of the leaf. Rarely will one find in the field more than two living larvae under enlarged webs on a single leaf. Occasionally one may see two or three empty mines or very small empty webs on a leaf.

The two magnolia trees mentioned in the introduction showed a far greater degree of infestation during 1959 than any other magnolia trees seen in Gainesville or other places in Florida. Many magnolia trees were examined. Some showed no signs of skeletonizer damage, while a few possessed an occasional injured leaf. Usually the number per tree was less than one per cent, but the damage on the two trees under observation was at least 25 per cent. On many branches, 10 to 20 per cent of the leaves were damaged, while others showed 50 per cent or more. Most of the observations included in this report were recorded from insects observed on the two heavily infested trees.

ADULTS: The over-all color of the small moth (Plate 1:1) is a mottled mixture of shades of brown, made up of light beige, medium to dark brown, and almost black scales grouped in irregular masses and lines. Each forewing is approximately 7 mm. in length and possesseses two irregular conspicuous dark areas, one near the proximal end and the other beyond the mid-region arising from the costal margin. The metathoracic wings are folded and located under the forewings when the insect is at rest. They are somewhat uniform in color, varying from a light beige near their bases

[1] Contribution No. 11 from the Department of Entomology, State Plant Board of Florida, Gainesville.

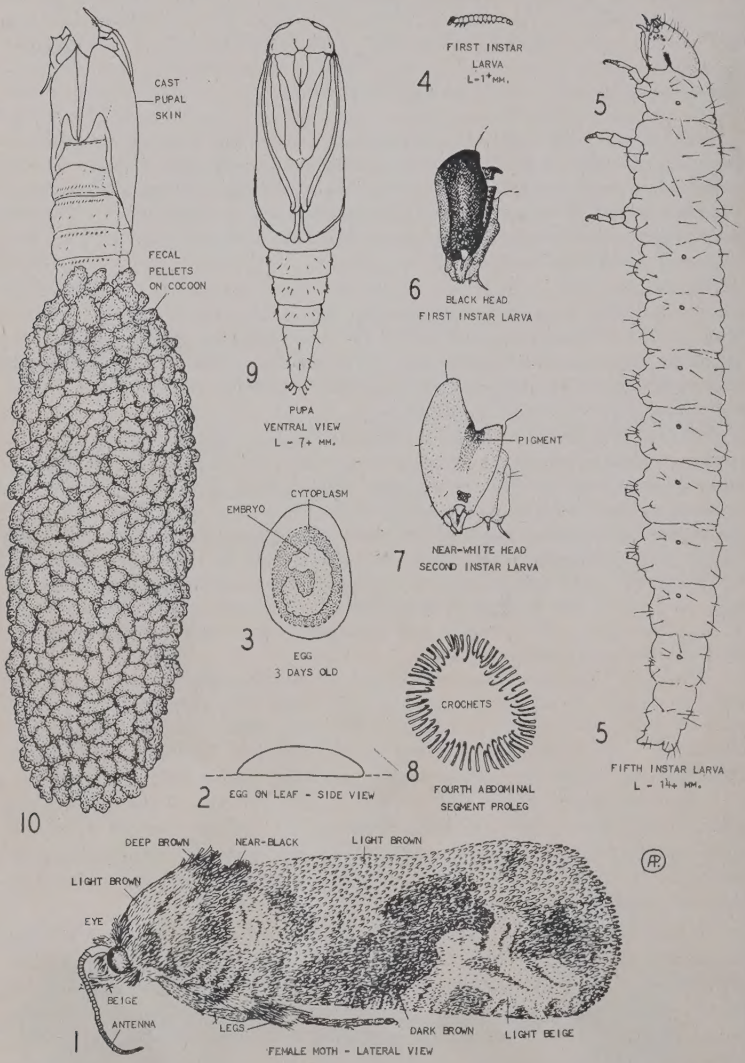

PLATE I

Life Stages of *Lobesia Liriodendrana* Kearfott

to a distinct grey near the tip ends. Long, light-colored scales occur on the outer margins of these wings.

A conspicuous tuft or mass of erect dark-colored scales occurs on the rear portion of the dorsal aspect of the thorax. The many segmented antennae are light brown with the distal portions near-black. The fairly conspicuous dark-colored eyes are deep brown and surrounded with elongated beige-colored scales which arise from the head and palpi.

In the laboratory adult females lived for 3 to 8 days when they had access to water. They were most active from the late afternoon until total darkness. During this period of activity eggs were deposited.

OVIPOSITION: Under field conditions, the female moths deposit their eggs on the upper glossy surface of magnolia leaves. In the laboratory, repeated tests were made with a few to many adults in various kinds of cages in order to obtain eggs. Small screen cages, 12" x 12" x 12", glass jars and vials lined with polyethylene or paper, and small polyethylene bags containing magnolia leaves and a water source were tried. All told, the deposition of eggs under laboratory conditions was unsatisfactory. In a few tests, a small number of eggs were found on the foliage of polyethylene.

EGGS: Eggs of the magnolia leaf skeletonizer (Plate 1: 2-3) are very similar to the eggs of several species of the Olethreutidae. They are smooth, flat, disc- or scale-like objects measuring approximately one millimeter across when viewed from above. Also, they are translucent, and consequently, when deposited on green foliage, the green color of the leaf

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PLATE I

Explanation of Life Stages on Plate I,
Figures 4, 5, 9 and 10 drawn to same scale

Figure 1.—Lateral view of a female moth at rest.

Figure 2.—Outline of the lateral view of an egg.

Figure 3.—Top view of a three-day-old egg deposited on a clear substrate showing, by transmitted light, a u-shaped embryo within surrounded by yellowish cytoplasm.

Figure 4.—A first instar, 1 mm. larva with a black, flattened head and habits of a leaf miner.

Figure 5.—A nearly full-grown, green, fifth instar larva with a light-colored rounded, prognathous head with external leaf-skeletonizing habits.

Figure 6.—Lateral view of a black, flattened head of a first instar larva. Drawn to same scale as Figure 7.

Figure 7.—Lateral view of an almost colorless (yellowish-white), rounded head of a second instar larva showing a lateral pigment area which also occurs in succeeding instars.

Figure 8.—Enlarged ventral view of the crochets on one fourth abdominal proleg of a fifth instar larva.

Figure 9.—Ventral view of a light or dark brown pupa.

Figure 10.—Dorso-lateral view of a pupa showing the slit on the dorsomeson through which the adult emerged, also, the normal position of the pupa in relation to its black, fecal-pellet covered cocoon at the time of adult emergence.

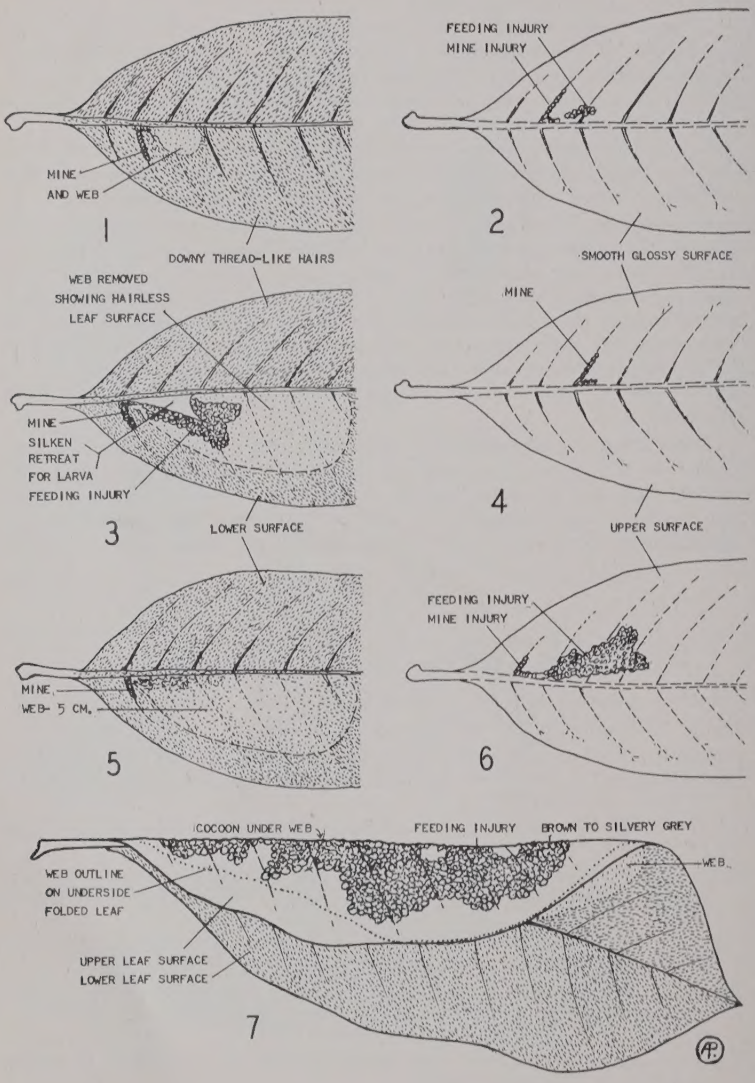

PLATE II

Leaf Injury Produced by *Lobesia Liriodendrana* Kearfott

is visible through the egg. When eggs are deposited on glass or colorless polyethylene, they are almost without color except for the slightly yellowish cytoplasm surrounding the nearly transparent embryos. As an egg develops, the embryo takes on a u-shape. Before it completes its development, it inverts its position, momentarily assuming an s-shape. The changes in the embryo can be seen by light reflected through the egg from below.

The incubation period of the eggs during the summer was 4 to 6 days. About 24 hours previous to hatching, the black head of the first instar larva shows as a black spot through the egg covering. This black-spot condition of the egg, when it is ready to hatch, is typical of many eggs of the Olethreutidae, Tortricidae, Pyralidae and other Lepidoptera. In hatching, the larva chews an exit opening in the egg covering.

LARVAE: A newly-hatched first instar larva (Plate 1: 4 and 6) approximates one millimeter in length. It possesses a flattened, black head with ocelli present on the lateral aspects.

PLATE II

Figures 1-7.—Magnolia leaves injured by single larvae while feeding or constructing their mines and webs. Figures 1, 3 and 5 show mines and webbed areas on the lower surface. Figures 2, 4 and 6 show mines and feeding injury from the upper surface.

Figure 1.—Leaf showing mine produced by a larva during its first instar and a one centimeter silken web produced by a late first instar or a second instar larva.

Figure 2.—Same leaf as figure 1 showing a mine and feeding injury from the upper surface.

Figure 3.—An infested leaf showing a web five centimeters in length, similar to Figure 5. The webbing has been removed to show the behavior pattern of the larva. Under the web, the downy thread-like hairs have been cut off and deposited on the outer surface of the web by the larva as it enlarges its domicile. The larva then proceeds to consume a portion of the smooth, green denuded surface. The feeding extends to the epidermis of the leaf's upper surface, producing a dead, brown to silvery irregular area. In addition to the above behavior, the larva constructs a white, tough, silken funnel adjacent to the main vein of the leaf. It uses this as a retreat when disturbed or when it is inactive.

Figure 4.—Leaf showing a v-shaped mine from the upper surface produced by a first instar larva located on the lower surface.

Figure 5. A five centimeter web constructed by a third instar larva on the lower surface of the leaf. It is always located on one half of the leaf and distad of the mined area. The outer surface of the web is covered with severed, downy, thread-like leaf hairs which are cut off by the larva and placed on the outer surface as it builds its web covering.

Figure 6.—Same leaf as Figure 5, showing the mine and feeding injury from the upper surface.

Figure 7.—The final stage of a 9 to 11 centimeter web constructed by a fifth (last) instar larva. In many cases the leaf is folded, often not as much as shown in this figure. Within and under the web the larva constructs a near-black cocoon attached to the leaf. The cocoon consists of white silk and is covered with near-black fecal pellets which, at this stage, are abundant under the web. When the adult is ready to emerge the pupa partially pushes its way out of the coccoon and splits its covering on the dorsum of the thorax. Upon emergence, the adult, when ready to fly, finds a hole in the web and escapes.

So far as observed, a newly-hatched larva on the upper surface of the leaf does not enter the leaf from this surface. Apparently, it wanders over the leaf (upper and lower surfaces) until it finds the mid-vein on the lower surface and usually enters the midvein not far from the petiole. A large majority of the mines produced by first instar larvae occur on the basal half of the leaf and almost invariably are adjacent to the midvein.

Upon entering a leaf, the larva constructs a small v-shaped mine (Plate 2:4) with one arm of the mine parallel with the midvein and the other portion parallel with a smaller lateral vein. This damage to the leaf is the work of a first instar larva.

About this time, the larva moults and produces a second instar larva which is an external feeder. It proceeds to build a web 1 or more centimeters in length. This V-shaped web starts at the V-shaped mine and, almost without exception, projects toward the tip end of the leaf adjacent to the midvein on one half of the leaf. A second instar larva averages 2 to 4 mm. in length and possesses a rounded, light-colored head (Plate 1:7) with a distinct pigment spot on each side adjacent to the caudo-lateral margins. Succeeding instars also have rounded, yellowish- to light-amber heads with pigment spots on the caudo-lateral margins (Plate 1:5).

After a small web is constructed, leaf feeding may begin under the web. Before a larva consumes the leaf tissue on the lower surface it cuts off the thread-like leaf hairs and deposits most of them on the outer surface of the webbing. This leaves a green area of plant tissue without obstructions when feeding occurs. A larva, in feeding, will consume all of the green plant cells at a given point until it reaches the epidermis of the leaf's glossy upper surface. This it does not destroy; consequently, when this surface dries and hardens, it appears as a grey or silvery membrane.

During the second instar and later, the larva constructs under its web and adjacent to the midvein an inner, elongated, firm white, silken, funnel-like retreat (Plate 2:3). When a larva is disturbed, it backs into this retreat. During the daytime, one seldom sees a larva feeding on the leaf as it is usually at rest in its retreat. It is probable that most feeding and web construction occurs at night.

As shown later, the larvae apparently passes through five instars. When the fifth instar larva is almost full grown, the webbing on the leaf may be 10 to 15 cm. in length and 3 to 5 cm. in width at its broad end. Occasionally, a full-grown larva will pull back the tip end of a leaf or pull over one edge (Plate 2:7) and anchor these parts with silk. Also, some larvae feeding on the area adjacent to a midvein will produce a distinct fold in the injured portion of the leaf under the web. Usually, the brown or light grey skeletonized dead tissue, seen best from the upper surface, does not exceed one-half of the area covered by the webbing on the lower surface.

A mature larva is 10 to 14 mm. in length and usually has a dull-green color. Before a cocoon is constructed, the larva produces a considerable amount of dark fecal pellets held together in loose masses by silken threads. Some of these masses may resemble cocoons except they are not compact and firm. Eventually the full-grown larva constructs a cocoon which it attaches to the midvein or some portion of the leaf. The cocoon is made of white silk and covered with dark fecal pellets.

Larval Instars: Dyar's idea, that the width of the head capsule of a lepidopterous larva is more or less constant for any instar of a given species,

was used to determine the number of instars among larvae of *Lobesia liriodendrana* (Kearfott) feeding on the leaves of magnolia during the middle of June at Gainesville, Florida. About 200 infested leaves were collected and brought to the laboratory for study. Over 150 larvae were removed from the infested leaves, killed in a K.A.A. mixture, and preserved in 95 per cent ethyl alcohol. The head capsule widths were measured with a cross-hatched eyepiece located in one ocular of a stereoscopic microscope. Each square under a 10 X ocular and 7.5 X objective measured 0.13 x 0.13 mm.

Figure A shows the number of head capsules of a given width on the vertical lines. To obtain an over-all trend, a running-average, plotted line was constructed. Each point on the line is the average number of individuals of 5 sizes, 2 to the left and 2 to the right of the line on which the point is placed. Figure A shows 5 prominent vertical lines and 5 elevations in the running average line. These points and the elevations on the line indicate strongly that there are 5 instars.

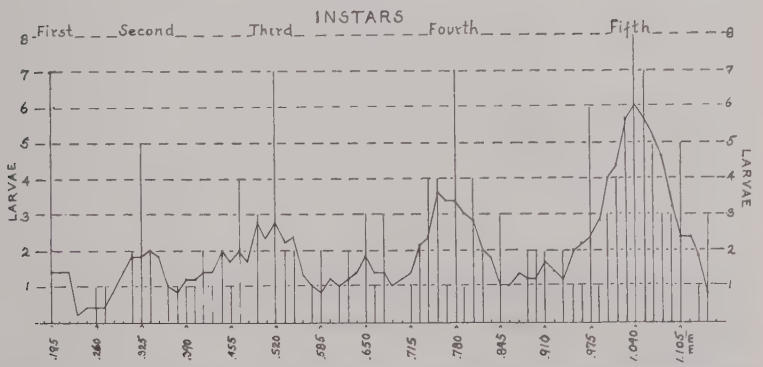

Figure A.—Larval Instars Determined by Widths of Head Capsules among 153 Larvae Collected at Random During June 1959 at Gainesville, Florida.

One might question the evidence for the second instar because the number is low. If the collection had been made late in May or early in June, the number of very small larvae probably would have been greater.

Dyar has also stated that the ratios of growth between the successive instars of a given species show a more or less regular geometric progression. If this idea is applied to the 153+ measured larvae of *Lobesia liriodendrana* (Kearfott), it will be noted that the ratios between the measurements, when it is assumed that there are 5 instars, are as follows: .60, .605, .66, and .75; while, if we assume that there are four instars, the ratios are .37, .66, and .75. In other words, the first series agrees much more closely with Dyar's idea of growth ratios than the second series.

In both series, the ratios between the last and next to the last instar are somewhat divergent from the previous ratios of .60, .605, and .66. This also holds for other species of lepidopterous larvae which the author has studied.

Until further study is made, it will be assumed that most larvae of this species pass through 5 larval instars.

LIFE CYCLES: When this investigation was started on April 20, 1959, all stages of the insect were found in the field. Consequently, the observations to date[2] do not reveal the complete life cycles of this insect for any single year.

As stated previously, eggs deposited on foliage during May to September required 4 to 6 days to hatch. Lower temperatures undoubtedly will increase the incubation period.

In order to determine the time required for a larva to complete its growth and transform into a pupa, two practices were pursued. In one procedure, close to 200 infested leaves were collected and brought into an air-conditioned laboratory. Some leaves were also placed in polyethylene bags in a screened insectary. The latter failed to produce results and all of the larvae died, probably due to the high temperature in the insectary and the excessive condensation in the containers where the leaves were kept.

During May, June and early July, leaves were brought into the air-conditioned laboratory, tagged individually and placed in polyethylene bags, 5 leaves per bag. The date of collection, size of the web, and other pertinent facts were recorded on the tags. The leaves were examined 3 times a week and all changes recorded on the tags. When the larvae started to construct a cocoon this was called the end of its growth period. As soon as a cocoon appeared, the leaf containing the cocoon was removed, cut down in size and placed in a separate polyethylene bag, and held for adult emergence. The above practice gave satisfactory results until early in July when it was noted that the picked leaves molded and turned dry before the larvae could complete their development. Another objection to this method of study is the fact that the leaves were kept in an air-conditioned room which differs decidedly from an outdoor environment. The 200 larvae used in these rearings gave the following results: larvae collected under webs 1 cm. in length, containing chiefly first or early second instar larvae, completed their growth in 10 to 21 days with an average close to 15 days, and the pupal period was 9 to 20 days.

The second practice pursued was the tagging of leaves on the tree, recording the development of the web once a week and the development of the insect a month or so after the leaves were tagged. When leaves were tagged, only those that showed normal, uninjured webs were chosen. For the most part, these were leaves with webs under 5 cm. in length.

Fifty leaves were tagged on June 10, examined twice a week and checked for final details on July 13th. This lot of tagged leaves had a total of 7 living larvae varying in size from 7 to 10 or more millimeters in length. All of the webs showed some tears. Most of these were badly riddled.

Fifty leaves tagged on June 18 and examined in detail on July 13th possessed eleven living larvae, mostly full grown, and two pupae in cocoons. Again, most of the webs were badly riddled and empty.

Another fifty leaves were tagged on July 14 and examined in detail on August 17. The results showed one full-grown larva, two empty pupal skins, two dead larvae in cocoons, and one dead parasite cocoon. All other webs were empty and torn, and, in most instances, badly riddled. This method for obtaining life cycle records was unsatisfactory, chiefly due to the

[2] The manuscript was submitted for publication in March, 1960.

fact that some predator entered the webs and destroyed the living larvae and pupae in the cocoons. The tagged leaves did show that some predator was responsible for the death of many larvae and pupae.

Pupae in Cocoons: When a full-grown larva is ready for pupation it spins a white cocoon which it covers with black fecal pellets (Plate 1:10). The cocoon is approximately 15 mm. long and 3 to 4 mm. in diameter. It is always under the webbing on the leaf and usually attached to the leaf adjacent to the midvein.

When emergence time for the adult approaches, the pupa pushes itself at least halfway out of the cocoon. At this point, the pupal covering splits along the dorsomeson and the adult emerges and escapes from the web via one or more holes found in most large webs.

The time the pupa spent in the cocoon during May to August varied from 9 to 20 days. Approximately two days of this time was spent in the prepupal stage. A newly formed pupa is light yellowish-brown but before emergence of the adult takes place, the color changes to a deep brown.

Natural Enemies: Natural enemies of the magnolia leaf skeletonizer are numerous, and, at times, appear to reduce the population decidedly.

Eggs were never plentiful or easy to find on the foliage. During the season approximately 50 eggs of *Lobesia* were seen. About one-half of these were parasitized by some species of *Trichogramma*. An egg, parasitized by *Trichogramma*, is black before and after the wasp has emerged.

Larvae and pupae of *Lobesia* are attacked by predators, hymenopterous parasites and disease pathogens. Early in the season chrysopid larvae were plentiful on the foliage. A few were seen feeding on small larvae of *Lobesia liriodendrana* (Kearfott).

Some predator, capable of tearing large holes in the webs, was fairly common early in the season. By midseason most of the webs showed some to excessive tears. It is evident that a predator larger than an average insect seeks and feeds on the larvae and pupae in cocoons under the webs. The author suspects birds. The only birds seen were mocking birds, cardinals and English sparrows. At no time did these species appear to be seeking larvae or pupae in the webs.

An occasional lizard of the genus *Anolis*, commonly referred to as a chameleon, was seen on the trees. It is suspected that they may feed on the larvae or pupae; however, it is known that these creatures usually attack objects that are in motion and not under a web.

An occasional parasite was found among the larvae collected. One was a species of *Macrocentrus*. Also, an occasional larva or pupa was found dead under the webbing covered with the mycelium of some unknown pathogen or secondary fungus.

In summarizing the information on the natural enemies of this host it is evident that predators play a decided role in the reduction of *Lobesia liriodendrana* (Kearfott), especially during the summer months.

During the months of October through December, there was a decided reduction in the activity of the predator which produced excessive tears in the webbing. On November 2, sixty-three leaves which appeared to be infested were collected. Only two of these were torn badly. Under the webs there were 33 living larvae, 9 pupae in cocoons, and 2 empty pupal skins. Again, on December 9, sixty-one leaves with normal webs were

collected. Under these webs were found 10 living larvae, 14 pupae in cocoons, and 15 empty pupal skins. All told, these observations showed that 64 to 70 per cent of the webs collected in November and December possessed living larvae, pupae or empty pupal skins, while similar collections made during July and August showed that only 5 to 20 per cent of the webs possessed living larvae, pupae or empty pupal skins.

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A NEW SPECIES OF MOTH INJURIOUS TO PINE (LEPIDOPTERA: BLASTOBASIDAE)

J. F. Gates Clarke
Smithsonian Institution

The species of moth described in this paper was received from Mr. Karl F. Wenger, Leader, Lake City Research Center, Southeastern Forest Experiment Station, U. S. Department of Agriculture, Lake City, Florida, through the Insect Identification and Parasite Introduction Research Branch, U. S. Department of Agriculture. Additional material was collected by Mr. Charles P. Kimball and a few specimens came from miscellaneous sources. Mr. Wenger submitted larvae, pupae, and adults for identification; some of each are preserved in the U. S. National Museum.

The length of the type series and large quantity of larvae received indicate that the species is abundant, presumably all along the Atlantic seaboard, within the range of its foodplants, and does considerable damage to the flowers and young cones of pines.

The figures for this paper were drawn by Mrs. Caroline Lutz, staff artist, Department of Zoology, United States National Museum.

Holcocera lepidophaga, new species

(Figures 1-2a)

Alar expanse 11-17 mm.

Labial palpus white, shaded anteriorly and laterally on second segment, with fuscous. Antenna ocherous white with narrow dark annulations; scape white. Head ocherous white with slight infuscation posteriorly; collar white. Thorax and forewing ochraceous-buff; extreme edge of costa ocherous white to outer third; underside of wing light fuscous; cilia pale ochraceous-buff. Hind wing grayish-fuscous; cilia pale ochraceous-buff. Legs white except: foreleg suffused with fuscous on outer side; tarsi of midleg fuscous; hind tibia tinged with ocherous and hind tarsi suffused with fuscous; abdomen white above tinged with ocherous beneath. The entire insect presents a glossy appearance.

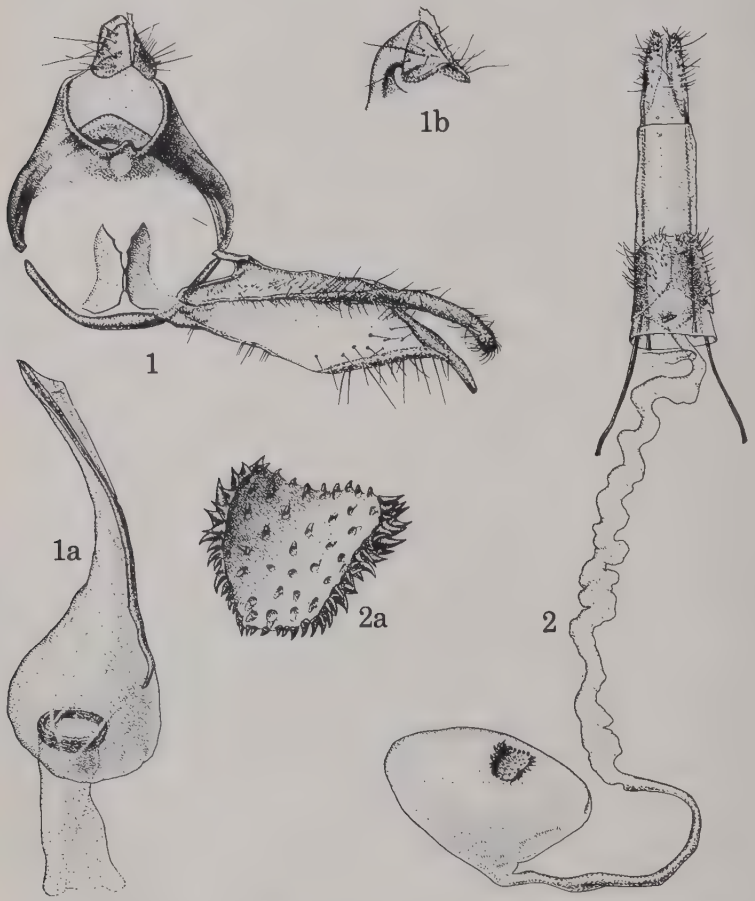
Male Genitalia: Costal edge of harpe produced into a bluntly pointed digitate process; cucullus long, curved, sharply pointed. Anellus composed of two sclerotized crescentic plates. Gnathos terminating in a broad subrectangular plate; posterior edge produced as a short, blunt point. Uncus divided distally into three winglike pieces arranged in a triangle. Aedeagus membranous except for a slender sclerotized rod and, basally, a sclerotized ring.

Female Genitalia: Ostium membranous. Ductus bursae membranous, somewhat spiraled; inception of ductus seminalis slightly before ostium. Signum a strongly sclerotized sub-rectangular plate.

Type: Male, Baker County, Florida (Em. 15.IV.58. Hopkins U. S. No. 40170). U. S. N. M. No. 64924.

Food Plants: *Pinus elliottii* Engelmann and *P. palustris* Mill. (According to a note accompanying the larvae: "Larvae mainly feeding into male

flower-buds and flowers or among basal scale leaves of cones and vegetative buds.)".



Figures 1-2a. *Holcocera lepidophaga*, new species. 1,Ventral view of male genitalia with left harpe and aedeagus removed; 1a, aedeagus; 1b, oblique view of distal end of uncus. 2, Ventral view of female genitalia; 2a, signum enlarged.

Described from the male type, 31 male and 6 female paratypes as follows: *Florida*: 4♂♂ 2♀♀, same data as type (April and May emergence dates); ♀, Columbia County, Em. 17.IV.58, B. H. Ebel; ♂, Torreya State Park, 29.IV.52, G. S. Walley; ♂, Siesta Key, Sarasota County, 1.V.56, C. P. Kimball; ♂, Archer, 3-82, C. V. Riley [specimen labelled "*Blastobasis* n. sp. Wlsm. .86"]; ♀, Camp Pichot, 14.II.32, P. C. Wakeley, No. 169-a[1]. *Massa-*

chusetts: 24 ♂♂, 2 ♀♀, Barnstable, June, July, August dates, 1949-52, C. P. Kimball.

Paratypes in the Canadian National Collection, Ottawa, Illinois State Natural History Survey, Urbana, State Plant Board of Florida, Gainesville, C. P. Kimball Collection, and the United States National Museum.

In general appearance this species most closely resembles *Holcocera augusti* Heinrich, described from Oregon and also occurring in Washington State, but *augusti* possesses an antennal notch in the male and the larvae feed in the cones of *Pseudotsuga taxifolia*. The uncus of *lepidophaga* immediately distinguishes it from any other described blastobasid; in *augusti* the uncus is pointed. Further, the males of the two species can be separated by the sclerotized rod of the aedeagus which is attached to the basal ring in *augusti* but detached in *lepidophaga*. The females can be distinguished by the signa. In *lepidophaga* the signum is a sub-rectangular plate, not ridged; in *augusti* the signum is elongate with a high transverse ridge.

Dr. Richard Selander, University of Illinois, who has been studying the Blastobasidae for the past several years, has kindly supplied the following notes: " . . . I have specimens from Barnstable, Mass., and Siesta Key, Florida. Its nearest named relative (as far as I can determine at present) is *Holcocera elyella*. Together with *elyella*, a species from Guatemala, and three other questionable forms, it constitutes what I have been calling the *Elyella* Group of *Holcocera*. . . . The group may be defined as follows: Male antenna without a basal notch; male clasper not enlarged, not platelike; first antennal segment (male) with a shield of scales covering pecten; a sclerotized ring at base of aedeagus, this not attached to sclerotized rod; aedeagus not forked. Female bursa with a single signum; signum a rounded oval plate, not ridged; abdominal sternum IX without a pair of callosities. The form of the uncus easily distinguishes *lepidophaga* (H22) from any other species of Blastobasidae I have seen."

ERRATUM: In the article by W. G. Genung, "Comparison of insecticides, insect pathogens and insecticide-pathogen combinations for control of cabbage looper Trichoplusia ni (Hbn.)", Vol. 43, No. 2, p. 66, line 15, the sentence should read:

> This material was used at a rate of 60 milliliters or 1.6×10^{11} polyhedra per 100 gallons of spray per acre.

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EUPALOPSIS AND EUPALOPSELLID MITES (ACARINA: STIGMAEIDAE, EUPALOPSELLIDAE)

F. M. Summers
University of California, Davis

The species to be considered here are little known mites which have been placed in two closely allied families, the Stigmaeidae and the Eupalopsellidae. *Eupalopsis* Can., 1889, appears to belong to the family Stigmaeidae. *Eupalopsellus* was separated from its namesake when Willmann (1952) proposed a new family, the Eupalopsellidae, and based it on the monotypic genus *Eupalopsellus* Sellnick, 1949.

One purpose of this study is to clarify as far as possible the status of the family Eupalopsellidae and to add to it new genera and species. The study was undertaken also because it has a bearing on *Mediolata* Can., an obscure stigmaeid genus already treated in part by the writer.

Berlese's opinion on the synonymy of *Mediolata* with *Eupalopsis* cannot be appraised because their genotypes are not available. His treatment of *M. longirostris* and *M. pini* as congeners of *Eupalopsis maseriensis*, the type species, does not quiet the matter, especially since his schematic illustrations of several generic characters of *Eupalopsis* (A. M. S. it., fasc. 51, N.8, pl. 78) are difficult to reconcile with the characters of *E. pini* as re-described here. Nevertheless there is a need for a definition of *Eupalopsis* when the Eupalopsellidae are set apart. It is possible now to accomplish only the latter by distinguishing between the species here called *Eupalopsis* and those which are to be described as eupalopsellids.

Review of pertinent literature indicates that all of the species formerly included in *Mediolata* have now been accommodated elsewhere. Its type species, *Stigmaeus longirostris* Berl. and a companion species, *Mediolata pini* Can., were transferred to *Eupalopsis* by Berlese (Ordo Prostig., p. 59). Berlese also placed *M. arvensis* Can. in synonymy under *Eupalopsis maseriensis* C. & F. *Mediolata mali* (Ewing) = *M. novae-scotiae* Nesbitt and *M. terminalis* (Quayle) have been removed to other genera (Summers, (1960).

Eight species have been referred to *Eupalopsis* but only three seem to be valid. The gross features of its type species, *E. maseriensis*, are known from its original description by Canestrini and Fanzago (1876) and from illustrations made by Berlese. Less clearly described is *E. longirostris* (Berl.), which Canestrini designated as the type of *Mediolata*. Only a third species is available for this study. This one almost certainly has four names, the earliest of which is *E. pini* Can., 1889 (= *pini* Berl., 1893, = *reticulata* Berl., 1910 = *pinicola* Ouds., 1923 = *punctulata* Ouds, 1923). Oudemans thought that *pini* Can. and *pini* Berl. were distinct but homonyms and he therefore proposed *pinicola* for the latter and *punctulata* for yet another which Berlese (1910) mentioned but did not name. This complication in *pini* arises from the fact that differences in the appearance of the ornamentation on the skeletal plates—dimpling, coarse reticulation, fine punctation, or simply no obvious pattern—was accepted as the basis for distinguishing between the species in question. Although the true genetic or functional significance of the cuticular dimpling or alveolation is ob-

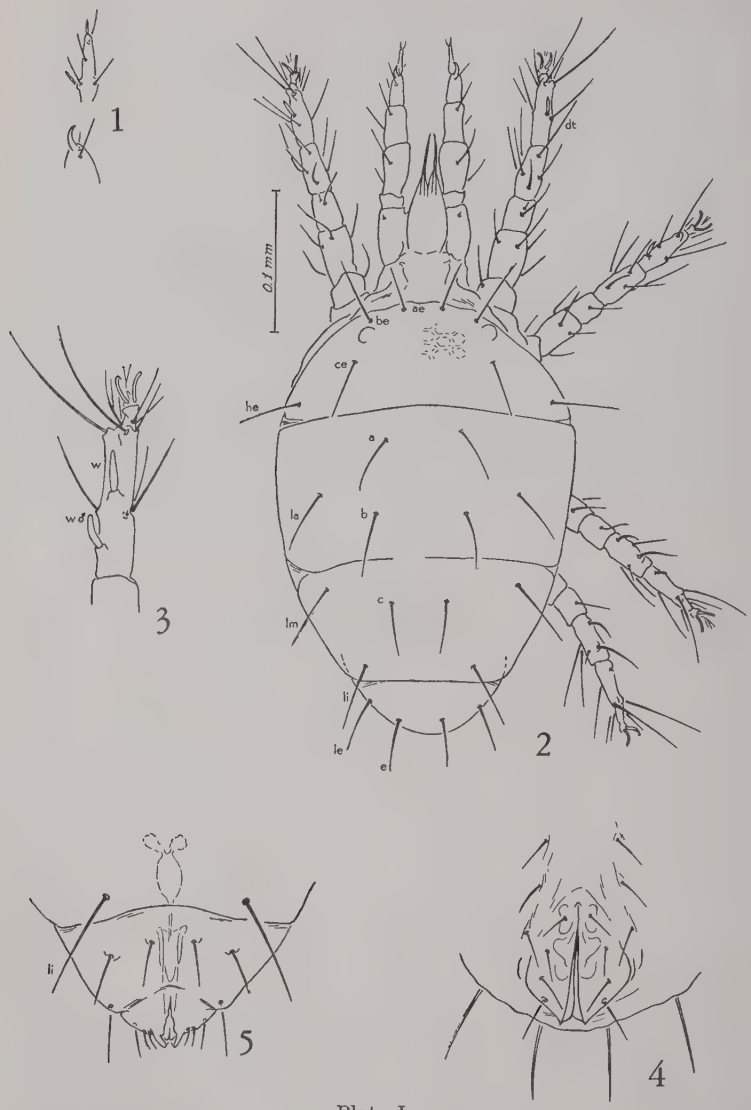


Plate I

Eupalopsis pini. Fig. 1, detail of right palptarsus and tibial claw separated; fig. 2, dorsal aspect of female, with reticular pattern on plates illustrated only on a small area of propodosoma; fig. 3, left tarsus I male; fig. 4, venter of female opisthosoma; fig. 5, caudal end of male, dorsal view. (Millimeter scale applicable only to nearest figure on this plate and on others which follow).

scure, it is the experience of the writer that, in some of the raphignathoid mites, optical demonstration of a cuticular ornamentation on specimens mounted in various media can be a hit-or-miss proposition. The synonymy given below for *E. pini* rests upon the writer's belief that cuticular patterns encountered in various populations of the same species were evaluated differently by Canestrini, Berlese and Oudemans.

Eupalopsis pini (G. Can.)

(Figs. 1-5)

Mediolata pini G. Canestrini, 1889, Atti d reale Ist. Ven. d. Sci., Lettre ed Arti 7: 526-6.

Eupalopsis pini R. Can., Berlese, A. M. S. it., fasc. 71, N. 10, pl. 81; Oudemans, 1923, Ent. Ber. 6(130): 149.

Eupalopsis reticulata Berl., 1910, Redia 6(2): 208; Oudemans, 1923, Ent. Ber. 6(130): 149.

Eupalopsis pinicola Ouds., 1923, Ent. Ber. 6(130): 149. NEW SYNONYMY.

Eupalopsis punctulata Ouds., 1923, Ent. Ber. 6(130): 149. NEW SYNONYMY.

FEMALE.—Chelicerae protrude prominently, their slender basal segments appressed, partly fused together in mid-line; fixed digits drawn out as slender prongs ensheathing needle-like stylets; both fixed and movable digits (stylets) tend to converge anteriorly. Rostrum slender, conical to truncated tip, overall length approx. equals combined lengths of palp trochanter and femur. Palpus unusually long (116μ total), diameters of its 5 segments gradually diminishing from trochanter to tarsus; when fully extended, tip of palpus projects almost to pretarsus of leg I; tibial claw diminutive, with one minute seta near its base to resemble accessory claw of other stigmaeids. Palptarsus (fig. 1) well developed, not pendant or subordinate to tibial claw; prolongs main axis of palp; without trifid sensillum. Setae (including seta-like sensilla) disposed on palp segments as follows: femur 2, genu 2, tibia 3, tarsus 6. Coxal regions of capitulum with only 1 pair long (32μ), flagelliform setae on ventral aspect, situated well behind baseline of rostrum, their alveoli separated by distance equal to greatest width of rostrum at base. Idiosoma moderately vaulted dorsally, gently tapered to a broadly rounded posterior. Eyes, 1 pair with dioptric apparatus. Anus subterminal. Dorsal plates thinly sclerotized, coarsely reticulated, covering almost entire dorsum but not reflected downward at sides to invade pleural integument; one extensive plate on propodosoma; three on hysterosoma, viz., one covering metapodosoma, a similar one covering most of opisthosoma, one suranal plate forms a caudal endpiece (fig. 2). Humeral platelets not identifiable as discrete elements, these apparently integral with propodosomal plate. Twelve pairs of slender, finely denticulate dorsal setae arranged as follows: 4 pairs on propodosoma including humerals *he*, 3 pairs on metapodosomal plate, 3 pairs on opisthosomal plate, 2 pairs on suranal plate. Those of pro- and meta-podosoma (except verticals *ae*) with length range 36-43μ, lateral pairs *lm*, *li*, on opisthosomal plate just noticeably longer (46-49μ) than all others. Venter without obvious coxal flanges or other plates. Six pairs ventral podosomal setae arranged as follows: 1 pair very long (47μ), exceptionally slender, between coxae II, their alveoli 36μ apart; 1 similar pair between coxae III,

48μ apart; 1 pair shorter setae (27μ) on hinder part of metapodosoma, 27μ apart; a longitudinal row of 3 pairs on opisthosoma of which 2 pairs are paragenitals. Ano-genital covers with 4 pairs short setae (fig. 4). Counts of setae, including special sensilla, on podomeres of legs I-IV are: femora 4-4-2-1, genua 2-1-1-1, tibiae 6-6-6-5, tarsi 12-10-8-8. Eupathid *dt* well-developed on tibia I only. Empodium with at least 2 pairs capitate raylets. Measurements in microns: length idiosoma, vertical setae to posterior end, 308; greatest width, 216; leg I, coxotroch. flexion to claw tips, 189; length preocular seta *be*, 41; intercalary seta *li*, 50; dorsomedian seta *c*, 40.

Male.--Closely resembles female in organization of gnathosoma, podosoma, legs. Idiosoma width/length ratio 177μ/280μ. Dorsal plates reticulated. Sex differences apparent on modified opisthosoma (fig. 5). Suranal plate invades venter to form a complete annular sclerite around opisthosoma; ano-genital aperture displaced to terminal position behind annulus. All dorsal setae except opisthosomal pair *li* approx. three-fourths as long as corresponding ones of female; pair *li* equally long in both sexes but, in male, appears proportionately longer in relation to those nearby. Two pairs setae on anal part of ano-genital covers reduced, spine-like; one pair only on genital part of covers. Ventral opisthosoma with but 2 pairs setae which may correspond to paragenitals of female, both pairs on ventral face of annular sclerite; anterior pair 25μ long, 18μ apart; posterior pair 31μ long, 50μ apart. Tarsus I with 2 small solenidia situated dorsally, in tandem (fig. 3); tarsus II with 2 similar solenidia, both proximal, almost side by side; tarsi III-IV with one solenidion each, these equivalent in size to those of tarsi I-II but corresponding in location to diminutive solenidion of female tarsi III-IV.

Collection Data.—2 ♀♀, Meyers, El Dorado Co., California, May 29, 1949 (Louis Isaak) *ex* pine leaf mold; 1 ♂, nr. Meyers, California, August 26, 1950 (S. F. Bailey) *ex* pine leaf mold.

The numerical measurements given above are applicable to one specimen of each sex. Only three specimens are available for this study, two females, one male. The male and one of the females have coarsely reticulated dorsal plates. The third specimen, a female, differs from the other female in two respects: its dorsal setae are about 25 per cent longer and it appears to have no reticulum when viewed with an ordinary microscope. Phase contrast microscopy, however, reveals a coarse, faint reticulum and clusters of alveoli which are arranged in polygonal patterns within each of the cells formed by the reticulum.

The specific descriptions which follow include measurements intended to be descriptive of relations between parts of one favorable study specimen and which do not necessarily express parameters for the species. Whenever possible, some of the measurements are given as means and standard deviations (M $\pm$ σ) calculated as for small samples.

Eupalopsis acus new species

(Fig. 6)

Female.—A very delicately sclerotized form with 3 pairs marginal indentations which mark sulci between dorsal plates. Basal articles of chelicerae apparently adnate but with separating walls retained. Palpi not

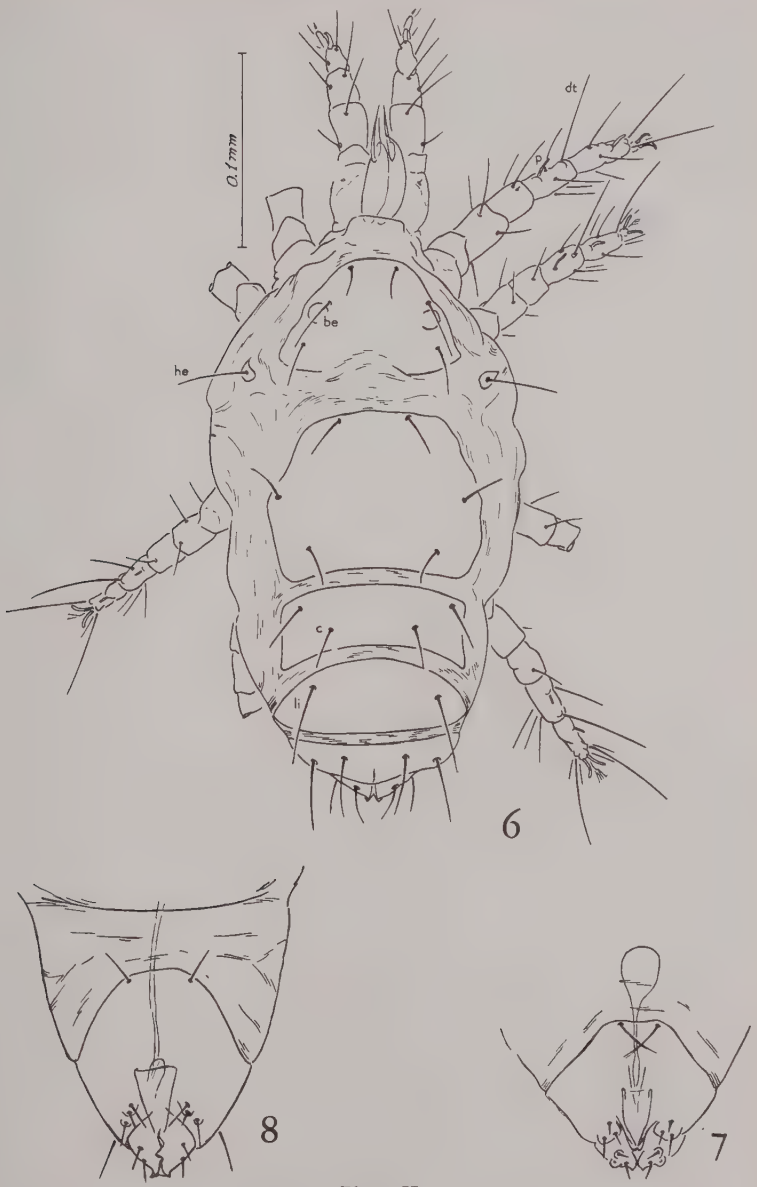


Plate II

Eupalopsis acus. Fig. 6, dorsal view of female; fig. 7, ventral opisthosoma, *Eupalopsellus ölandicus*, male; fig. 8, venter of opisthosoma, *Eupalopsellus trudis*, male.

uniquely slender or elongate; tibial claw well-developed; palptarsus not longer than palptibia, carried as in usual claw-thumb arrangement. Setae on palp segments as follows: femur 2, genu 2, tibia 2, tarsus 6. Gnathosoma with but 1 pair ventral, flagelliform setae. Arrangement of dorsal plates diagnostic: propodosomal plate circumscribes area occupied by 3 pairs propodosomal setae, posterior margin submerged or invaded by striae; humeral plates isolated in usual position; metapodosoma almost covered by a single large plate; opisthosoma with 2 unpaired plates over tergum and a terminal end-plate (suranal). Dorsal setae: 12 pairs, all relatively fine, slender, faintly denticulate; majority short, of uniform length (ca. 22μ); humerals *he* somewhat longer (34μ); intercalary pair *li* longest (40μ); posteriormost setae of opisthosoma noticeably longer, more robust than those on propodosoma. Ventral setae on podosoma very long, flagelliform; individuals of anterior pair not appreciably longer than distance apart (31μ); middle pair longer but not overreaching bases of first pair; third pair between coxae IV shortest (15μ) and closest together (27μ). No genital plate surrounding ano-genital covers. Counts of setae and sensilla on legs I-IV: femora 4-4-2-1, genua 3-1-1-1, tibiae 6-6-6-6, tarsi 12-10-7-7. One inflated solenidion on all tarsi; those on tarsi I-II stubby, each about 5 times as long as its greatest diameter; those on tarsi III-IV similar to each other, smaller than on forelegs. Distal eupathid *dt* well developed on all tibiae; proximal solenidion *p* nearly identical on all tibiae, each solenidion with truncated tip, length not greater than solenidion of tarsus I. Measurements in microns: length idiosoma, vertical setae to posterior extremity, 280; greatest width, 165; leg I, coxo-troch. artic. to claw tips, 134; length preocular seta *be*, 23; intercalary seta *li*, 38; dorsomedian *c*, 18.

Male.—Not known.

Holotype.—Female, Summerland, B. C., Canada, Feb. 26, 1956 (D. H. Chant), *ex* apple (Mason Orchard). Deposited in collection of United States National Museum.

Other Specimens.—Female, Iran (intercepted at Washington, D. C.), Mar. 4, 1954 (H. Y. Gouldman), *ex Prunus*, budwood.

The peculiarities of the species are found in the pattern of the hysterosomal plates. The metapodosoma is covered by one large hexagonal plate having 3 pairs of setae. The opisthosomal armature comprises 2 tergal plates, an anterior rectangular plate with 2 pairs of setae and a posterior lenticular plate having but one pair of setae (*li*); this unit plate undoubtedly corresponds to a pair of intercalary plates commonly present in other Stigmaeidae (Summers, 1960).

It is suspected by the writer that this species is a very close relative of *Eupalopsis longirostris* Berl., the type species of *Mediolata* G. Can.

Basis for Separating the Stigmaeidae and Eupalopsellidae

It is sufficient for present purposes to regard *Eupalopsis pini* and *E. acus* as congeners. The essential problem is to distinguish these and other stigmaeids from the eupalopsellids.

Although Willmann (1952) proposed the Eupalopsellidae as a new family, he did not particularize the basis for separating it from the Stigmaeidae. Separation can be achieved on the basis of three characters. (1) The Stigmaeidae, including the above species of *Eupalopsis*, possess a

characteristic empodium. This consists of an erect rod-like axis on which arise directly or indirectly at intervals several pairs of empodial raylets, usually 3 pairs. Although the point requires further study, it often appears that the axial blade or rod branches into 3 unpaired secondary axes, all in the same plane, and these in turn bifurcate into right and left raylets, 3 pairs for each empodium. The Eupalopsellidae have at least 2 pairs of raylets which are sessile on a median knob of the tarsus; the erect axial rod is not present (c.f., fig. 11). (2) A terminal sensillum or trident is present on the palptarsus in most but not all of the Stigmaeidae. Grandjean (1946) typed this specialized structure as a multiple eupathid. It is well-developed in many stigmaeids (e.g., *Stigmaeus, Ledermuelleria, Cheylostigmaeus*), barely discernible as a trident in some (e.g., *Zetzellia, Agistemus*), supplanted by several independent eupathids (*Apostigmaeus*), or single and unbranched (*Eupalopsis*). The eupalopsellids have only a single unbranched sensillum on the apex of the palptarsus. (3) The Eupalopsellidae possess a pair of posterior dorsocentral setae *pm* on the propodosoma (fig. 10), the individuals of which tend to lie close together. Stigmaeids do not have this particular pair, although there may be uncertainty when pairs almost in this position are homologized between *Macrostigmaeus* and *Apostigmaeus* (Stigmaeidae) and one of the new genera described in the Eupalopsellidae (fig. 22).

Other tendencies which approach extreme condition in the Eupalopsellidae are: pronounced elongation of the mouthparts, complete adnation of the cheliceral bases, long palptarsi, and reduction or absence of the palp claw. The dorsal plate patterns are not diagnostic for the family.

Eupalopsellidae Willmann, 1952

Right and left basal articles of chelicerae completely coalesced to constitute a stylophore. No obvious peritremata on gnathosoma. Palps notably slender, attenuated. Tibial claw reduced or obsolete. Palptarsus at least as long as tibia, usually much longer, carried as a forward extension of the main axis rather than as a pendent lobe or "thumb"; its terminal sensillum a minute spike or pointed brush, not a trident. Fixed cheliceral digits attenuated, completely ensheathing long, sharply-tipped stylets. Dorsum with 13 pairs setae, including a posterior dorsomedian pair *pm* on propodosoma. Dorsal plates, when present, may be continuous over entire back or subdivided as a series of unpaired plates of which 3 cover hysterosoma; sclerotization appears to be continuous when setae are elaborate blades or spines with basal tubercles, subdivided or almost absent when setae are delicate, flexible. Venter of female without plates. Ventral podosomal setae exceptionally long, flagelliform. Empodium rudimentary, present as a rounded elevation of tarsus from which roots of tenent raylets take origin; usually 2 pairs raylets, much longer than claws, individuals of each pair unequally long, all tipped with concave adhesive pads.

The family is amended to include the two new genera and five new species described below.

Eupalopsellus Sellnick, 1949

Gnathosoma and associated appendages delicate, slender, elongate. Palptarsus approximately as long as tibia plus genu. Idiosoma incompletely

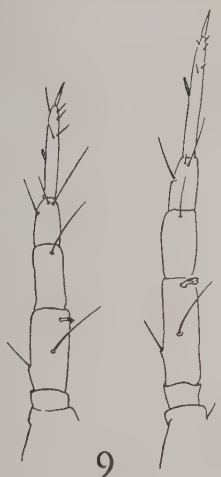
covered with 4 unpaired dorsal plates: propodosomal, metapodosomal, opisthosomal, suranal. Species for which males have been identified have distal seta of palpfemur modified as a short, peculiar, brush-like blade, and lateral suranal seta *le* absent.

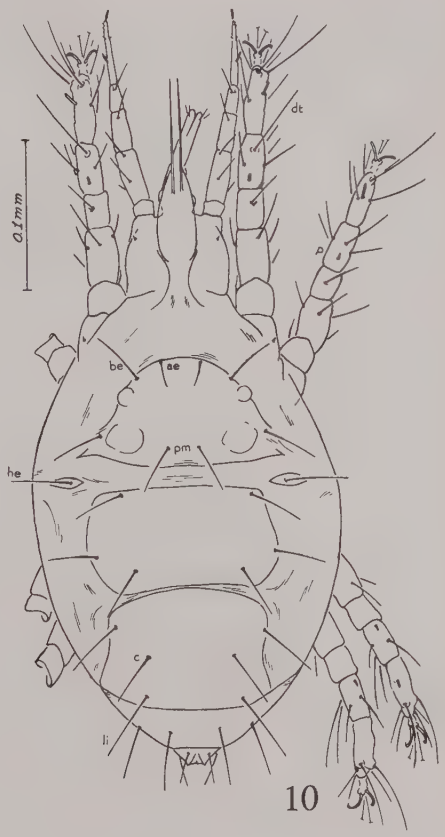
TYPE SPECIES: *Eupalopsellus ölandicus* Sellnick.

Eupalopsellus ölandicus Sellnick, 1949, Ent. tidskr. 70(3): 123-35; Willmann, 1952, Verofftl. Inst. Meeresf. Bremerhaven 1: 163-5.

FEMALE.—Gnathosoma with appendages slender, total length from idiosomal union to palpal tips close to 0.7 as long as idiosoma, vertical setae to anus. Chelicerae with fine, straight, fixed and movable digits set close together at proximal ends, convergent at tips; length of needles (79μ) exceeds length of fused basal pieces (67μ). Rostrum as long as fixed digits, basal half conical, distal half with parallel margins to notched tip. Palpus gradually tapered from trochanter to pointed tarsus, total length 0.75 as long as corresponding parts leg I; ratio lengths genu/femur = 0.7. Palptibia with a very short seta-like structure at position normally occupied by claw, this one-sixth as long as seta next adjacent. Palptarsus 52μ to end of terminal sensillum, slightly longer than combined lengths of genu and tibia (45μ). Sensilla and setae on palp segments: femur 3, genu 1, tibia 3, tarsus 7. Ventral setae of gnathosoma long, flagelliform, anterior pair at least 32μ long, 9μ apart, on rostral cone; posterior pair at least 43μ long, 14μ apart, on basis capitulum. Idiosoma an elongate oval; flattened, mounted specimens without emphatic humeral constriction, anus terminal, visible from above. Dorsum partly covered by 4 median plates—propodosomal, metapodosomal, opisthosomal, suranal—as illustrated (fig. 10). Each humeral seta *he* originates on its own separate humeral platelet. Metapodosomal, opisthosomal plates roughly quadrilateral, each wider than long. Major plates with small punctations. Dorsal setae normal, pointed, finely denticulate; 11 of 13 pairs subequal, intercalaries *li* longer, verticals *ae* shorter than others. Ventral setae of podosoma whip-like; anterior pair at least 75μ long, 34μ apart, between coxae I; middle pair at least 75μ long, 68μ apart, between front margins of coxae III; posterior pair at least 41μ long, 50μ apart, between coxae IV. Legs subequal; inclusive counts of setae and sensilla on individual podomeres: femora 4-4-2-1, genua 2-1-0-0, tibiae 6-5-5-5, tarsi 11-9-7-6. Seta *dt* a long eupathid on tibia I only; this seta absent on tibiae II-IV. Solenidion *p* of tibiae I-II unusually tiny (5-6μ long), corresponding sensilla on tibiae III-IV further reduced to minute pegs. Spine *k* on genu I set close to base, almost directly behind dorsal seta. Sample measurements in microns ($\bar{M}\pm\sigma$,n=9): length idiosoma, vertical setae to end suranal plate, 276±18; greatest width, 205±19; leg I, coxotroch. flexion to claw tips, 189±5; length preocular seta *be*, 34±3; intercalary seta *li*, 55±3; dorsomedian *c*, 36±3.

MALE.—Anatomical features of body plates, their surface architecture, mouthparts, chaetotaxy essentially as in opposite sex. Sex differences revealed in slightly reduced dimensions, conical opisthosoma, genitalia, unique sensilla. Opisthosoma a truncated cone, with lateral suranal setae *le* absent or with uncertain identity on venter. Genital plate covers posterior half of opisthosoma, laterally continuous with suranal plate above to form an annulus; anterior pair genital setae near anterior margin of genital





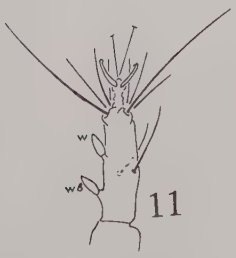


Plate III

Eupalopsellus ölandicus. Fig. 9, left palpus of male *ölandicus* (right) and *trudis* (left); fig. 10, dorsum of female *ölandicus*; fig. 11, left tarsus I, male of *trudis;* fig. 12, left tarsus I, male of *ölandicus.*

plate, corresponding in size, location with anterior genitals of female; other associated setae shortened, closely grouped (fig. 7). Intromittent organ a slender tube extending backwards from neck of a drop-shaped vesicle, retracted tip sheathed in a chamber of complex pattern. Male solenidion *w* ♂ appears on tarsi I-IV in proximal position (fig. 12); very small solenidion *w* and larger *w* ♂ close beside each other on tarsus II. Distal seta of palpfemur present as a stubby, brush-like rod (fig. 9, right).

Collection Data.—2 ♀♀, Cherry Creek, Idaho, Jul. 23, 1949 (G. F. Knowlton and Shi-Chun Ma), *ex* sagebrush; 4 ♀♀, 1 ♂, Logan, Utah, Nov. 4, 1950 (G. F. Knowlton and E. H. Kardos), *ex* sagebrush; 5 ♀♀, Logan, Utah (Logan Canyon), Oct. 21, 1950 (G. F. K. and E. H. K.), *ex Artemisia* sp.; 1 ♀, Yakima, Washington, May 21, 1951 (E. W. Baker), *ex* sage; 3 ♀♀, Harwood, Washington, Jul. 13, 1951 (R. W. Burrell), *ex* "white sage", Elliott Orchard.

The diagnostic features of *E. ölandicus* are: dimensions, shapes and punctate alveolations of dorsal plates, and the setal modifications on the tibiae. Eupathid *dt* is well developed on tibia I but is not represented on tibiae II-IV. The proximal solenidion *p* of tibiae I-IV is abnormally reduced to a minute peg. Supplemental characters include the presence of a seta-like structure instead of a claw on the palptibia, the occurrence of separate humeral platelets, and the peculiar modification of the anterior dorsal seta on the palpfemur of the male.

These specimens from western United States appear to be identical with *E. ölandicus* as described by Sellnick (1949) from material collected beneath stones near the coast of Sweden, and with the male described by Willmann (1952) from lichen-covered pine bark. All of the American examples so far examined were taken from *Artemisia* spp. or the mulch thereunder. In one instance the eupalopsellids were found in a population sample of the false spider mite, *Brevipalpus aeolus* P. and B.

Eupalopsellus rostridius new species

(Figs. 13, 16)

Female.—Length gnathosoma, base to palptarsal sensillum inclusive, approximately 0.7 as long as idiosoma, vertical setae to anus. Rostral width at base of conical section less than one-fourth its total length, margins parallel for most of length. Palp close to 0.85 as long as corresponding parts leg I; ratio length genu/femur = 0.9; tibial claw present but vestigial, less than 0.1 as long as adjacent seta; palp setae otherwise distributed as in *ölandicus*. Ventral gnathosomal setae: anterior pair at least 31μ long, 7μ apart; posterior pair at least 41μ long, 14μ apart, on basis capitulum. Dorsal plates arranged as illustrated (fig. 16), without apparent alveolations; humeral platelets not evident. Dorsal setae fine, very faintly denticulate; preoculars *be* (23μ) shorter than postoculars *ce* (31μ). Ventral podosomal setae originate on small tubercles; front pair at least 90μ long, 27μ apart; middle pair at least 81μ long, 41μ apart; posterior pair at least 23μ long, 29μ apart, between coxae IV. Setae and sensilla legs I-IV; femora 4-4-2-1, genua 2-1-1-1, tibiae 6-5-5-5, tarsi 11-10-7-6. Solenidion *p* on tibia I comparatively long (18μ), progressively diminishing on successive legs to 9μ on tibia IV. Measurements in microns (1 specimen): length idiosoma,

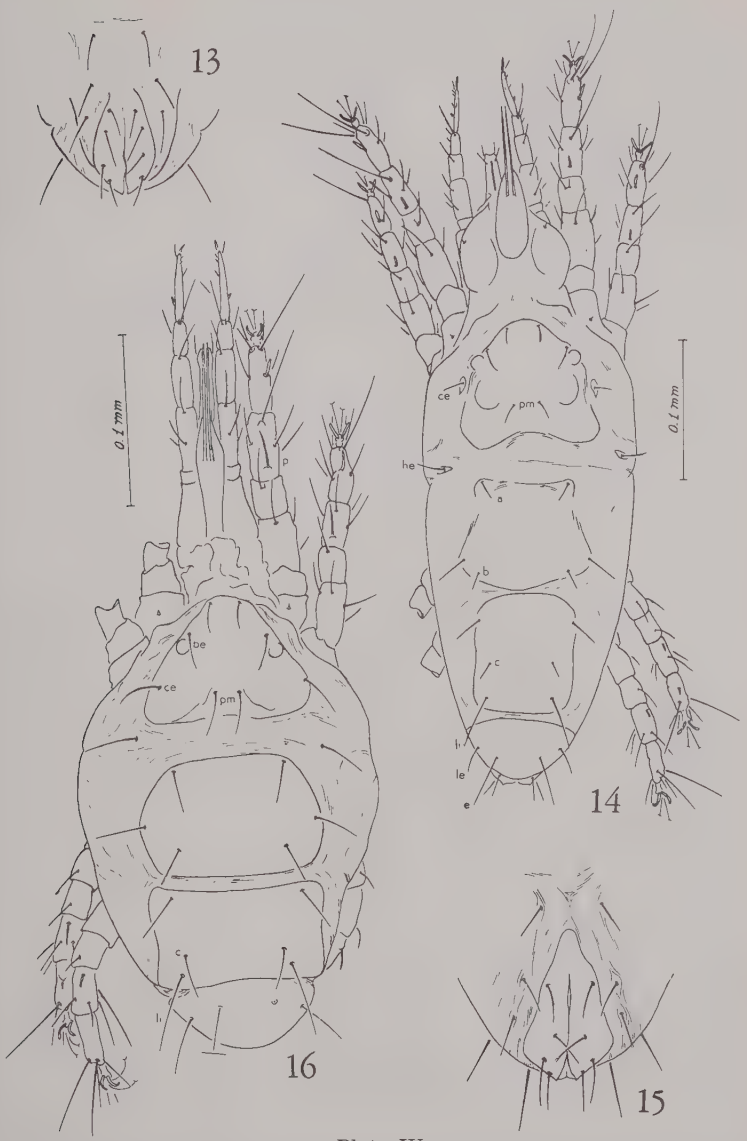


Plate IV

Eupalopsellus trudis and *E. rostridius.* Fig. 13, venter of female opisthosoma, *rostridius;* fig. 14, dorsal view, female of *trudis;* fig. 15, venter of opisthosoma, female of *trudis;* fig. 16, dorsal aspect, female of *rostridius.*

263; greatest width, 167; leg I, 160; preocular seta *be*, 23; intercalary seta *li*, 47; dorsomedian *c*, 25.

MALE.—Not known.

HOLOTYPE.—Female, Scotland, Sept. 9, 1937, intercepted at Boston, Lot 37-23283 (J. T. Beauchamp), *ex* heather. In the collection of the United States National Museum.

This new species is very closely related to *ölandicus*. There are a number of quantitative differences between the two species, but some of these may not assuredly aid in defining the new species because measurements for the single specimen do not establish accurate parameters for a population. Several clear-cut distinctions between *rostridius* and *ölandicus* are found in the chaetotaxy of certain podomeres. Setae on the genua are 2-1-1-1 in the former, 2-1-0-0 in the latter. Solenidion *p* on tibia I of *rostridius* is well developed and approximately as long as the dorsolateral seta next in front; the corresponding sensillum of *ölandicus* is uncommonly short and stubby. Additional differences occur in the length and spacing of the ventral podosomal setae; preocular seta *be* is shorter than postocular *ce* on *rostridius*, approximately equal in *ölandicus*. The length ratios of palp segments genu/femur are 0.9 (*rostridius*) and 0.7 (*ölandicus*). The peculiarly narrow basal part of the fused chelicerae, as illustrated, may not be characteristic. This grotesque condition is perhaps due to collapse.

Eupalopsellus trudis new species
(Figs. 8, 11, 14, 15)

FEMALE.—Slender-bodied, spindle-shaped species with legs in widely separated groups. Legs short in relation to body, approximately equal to greatest body width. Possesses essential features and chaetotaxy of *ölandicus* but with certain quantitative differences. Palpus 106μ long, approximately 0.6 as long as corresponding segments of leg I; length palp-tarsus 36μ, equal to palp tibia plus genu; seta in claw position on palp-tibia comparatively long (7μ), equals one-third length adjacent dorsal seta. Ventral setae on gnathosoma: anterior pair 20μ long, 8μ apart, on rostrum; posterior pair 29μ long, 22μ apart, on basis capitulum. Propodosomal plate invaded by striae laterally, such that postocular setae *ce* appear to occur on isolated platelets, one side or both. Humeral platelets absent or represented only by divarications of striae around bases of setae *he*. Dorsal metapodosomal plate barely wider than long; opisthosomal plate almost rectangular, slightly longer than wide. All plates without apparent surface ornamentation. Dorsal setae short, slender, so faintly denticulate as to appear almost smooth; setae on propodosoma essentially alike; dorsomedians *a*, *b*, *c*, on hysterosoma equal to each other but clearly shorter than dorsolaterals; intercalary seta *li*, median suranal *c* longer than other dorsals, both more than twice as long as dorsomedian *c* on opisthosoma. Ventral setae on podosoma flagelliform, so delicate that accurate measurement very difficult, each arises from a minute tubercle; anterior pair at least 97μ long, 32μ apart, between coxae I; middle pair 95μ long, 52μ apart, anterior to front margins of coxae III; posterior pair 18μ long, 32μ apart, between coxae IV. Special sensilla on appendages not describably different from those of the type species; podomeres with numbers of setae differing from *ölandicus* are: femur III—3, genu III—1, tibia IV—1, tarsus II—10.

Sample measurements in microns ($\overline{M}$ only, n = 3): length idiosoma, verticals to posterior end, 340; greatest width, 168; leg I, 169; preocular seta *be*, 19; intercalary *li*, 40; dorsomedian *c*, 14.

Male.—Description of female also applicable to male except opisthosoma and certain sensilla of appendages. Metapodosoma perceptibly constricted at union with conical opisthosoma. Suranal plate enwraps posterior, continuous with expanded genital plate below (fig. 8). Ano-genital covers displaced to terminal position, associated setae shortened, closely grouped. Lateral suranal setae *le* absent, or with uncertain identity on venter. Male solenidion $w\delta$ in proximal position on all tarsi; distal solenidion *w*—homologue of slender *w* of female—inflated on male tarsi I-II, identical in size, conformation with $w\delta$; these sensilla stubby, acorn-like, each not longer than twice its diameter (fig. 11). Upper distal seta on palp-femur transformed into a blunt, brush-like peg (fig. 9, left).

Types.—Holotype female, allotype male, one slide, Ogden Canyon, Utah, Sept. 16, 1952 (G. F. Knowlton), *ex Damparia*. Deposited in United States National Museum. Two paratype ♀♀, Logan, Utah, Feb. 24, 1951 (G. F. K. and E. H. Kardos), *ex* dead leaves and grass; paratype ♂, Logan Canyon, Utah, Oct. 21, 1950 (G. F. K. and E. H. K.), *ex* grass, sage brushland; 1 deutonymph, Logan Canyon, Utah, Nov. 19, 1949 (G. F. K. and Shi-Chun Ma), *ex* red juniper. Paratypes in author's collection, University of California, Davis.

The distinguishing features of *E. trudis* are: slender, elongate body shape, elongate dorsal plate on opisthosoma, alternation of short dorsomedian setae with longer dorsolaterals, and acorn-like inflated sensilla on the tarsi of males.

Exothorhis new genus

Dorsal idiosoma entirely covered by a thin skeletal sheath not clearly subdivided into discrete plates. Dorsal body setae and dorsals of proximal leg segments stout, coarsely denticulate, subequal, all originate on tubercles. Humeral setae *he* displaced upward from pleural position to appear as supers in dorsolateral series. Tibial claw of palp reduced or obsolete.

Type Species: *Exothorhis caudata* new species.

Exothorhis caudata new species
(Figs. 17-20)

Female.—Smallest representative of its family. Cheliceral basal piece attenuate, about twice as long to separation of digits as greatest width near base; movable digits very long, 45μ proximal flexure to needle tips, slender, converging at tips, sheathed to ends by fixed digits. Rostrum similarly produced, conical to basal third, distal two-thirds cylindrical. Ventral gnathosomal setae long, flagelliform; anterior pair 27μ long, 13μ apart, on conical base of rostrum; posterior pair 43μ long, 16μ apart, on maxillicoxae. Palpi well proportioned, 90μ overall length, or close to one-half length leg I coxa to pretarsus. Tibial claw present but small. Palptarsus slightly less than one-third total palp length. Setae and sensilla on palp segments: femur 3, genu 1, tibia 2, tarsus 7. Idiosoma a blunt spindle

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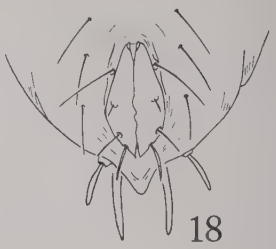

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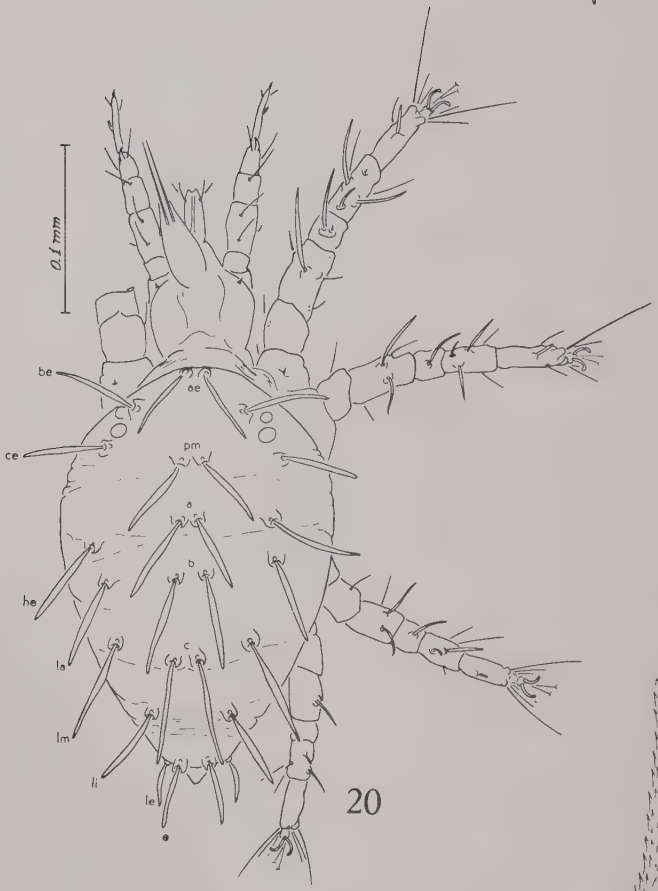

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Plate V

Exothorhis caudata, female. Fig. 17, lateral view of opisthosoma to illustrate blunt, down-curved papilla; fig. 18, venter of opisthosoma with ano-genital covers; fig. 19, postocular setae *ce* of two individuals from one collection; fig. 20, dorsal view of body.

shape, dorsum totally covered with a thin, non-textured skeletal sheath, individual plates not discernible. Dorsal setae very prominent, stout, almost straight, coarsely denticulate; all tapered to pointed tips or (many specimens) of uniform diameter to bluntly rounded ends (fig. 19); vertical setae *ae* often shorter than pair next adjacent; dorsomedians *b*, *c* on opisthosoma slightly longer than all others; lateral suranals *le* much shorter, less robust than median suranals *e*. All heavy setae on tubercles. Humeral platelets and setae *he* not surely identifiable—possibly first lateral hysterosomals (supers) represent displaced humeral setae; individual setae of anterior three pairs dorsomedians arise so close together that their tubercles are contiguous; pressure of coverglass on dorsal setae tends to fold cuticula into false sutures. Ano-genital covers subterminal, pendant beneath a papilla-like extension of opisthosoma; papilla forms a blunt, downwardly curved tailpiece—hence *caudata* (figs. 17, 20). Anterior pair ventral setae at least 75μ long, 36μ apart on propodosoma; middle pair traced to at least 68μ long, 48μ apart; third pair between coxae IV at least 24μ long, 80μ apart. Anterior pair setae on ano-genital covers much longer, second pair much shorter than posterior 2 pairs nearest anus (fig. 18). Leg I longest, each succeeding leg shorter, leg IV approximately three-fourths as long as leg I. Dorsal setae on femora, genua, tibiae are smaller replicas of dorsal body setae. Distribution of setae and sensilla on leg podomeres: femora 4-4-3-1, genua 2-1-1-0, tibiae 6-5-5-5, tarsi 10-9-7-6. Distal sensillum of tibia I (corresponding to eupathid *dl* of other species) reduced to a minute spine no larger than spine *k* of genu I, this sensillum absent on tibiae II-IV. Spine *k* of genu I so close to base of stout dorsal seta that their tubercles are confluent. Proximal solenidion of tarsus III not present on tarsus IV. Sample measurements in microns ($\bar{M} \pm \sigma$, n=10): length idiosoma, insertion vertical setae to cauda, 261 ± 18; width, 174 ± 18; leg I, coxotroch. flexion to claw tips, 190 ± 12; preocular seta *be*, 51 ± 4, intercalary seta *li*, 54 ± 4; dorsomedian seta *c*, 60 ± 7.

Male.—Not known.

Holotype.—Female, Lake Alfred, Florida, Block 20, University of Florida Citrus Exp. Sta., May 25, 1959 (D. W. C.), *ex Citrus*. Holotype and 3 paratypes in author's collection, University of California, Davis. Paratype female in United States National Museum.

Collection Data.—One ♀, Winterhaven, Fla., Nov. 19, 1953 (M. H. Muma), *ex* citrus leaf; 1 ♀, Fort Pierce, Fla., Oct. 19, 1954 (H. L. G.), *ex* grapefruit; 1 ♀, Fort Pierce, Fla., Aug. 18, 1955 (H. L. G.), *ex* scale-infested leaf (citrus?); 2 ♀♀, Weirsdale, Fla., Jun. 22, 1955 (H. L. G.), *ex* — ; 1 ♀, Haines City, Fla., Jun. 6, 1959 (H. L. G.), *ex* citrus (Fletcher Grove); 2 ♀♀, Fort Pierce, Fla., Feb. 17, 1959 (H. L. G.), *ex* orange leaf; 6 ♀♀, Orlando, Fla., Apr. 13, 1959 (A. G. Selhime), *ex* citrus lvs. with scales; 1 ♀, Weirsdale, Fla., Jun. 1, 1959 (D. W. C.), *ex* —.

The identifying characters of *E. caudata* are: small size, down-curved papilla on the posterior tip of the opisthosoma, structure of dorsal setae, the minute sensillum on the upper, distal part of tibia I, and absence of this sensillum on corresponding podomeres of the other legs.

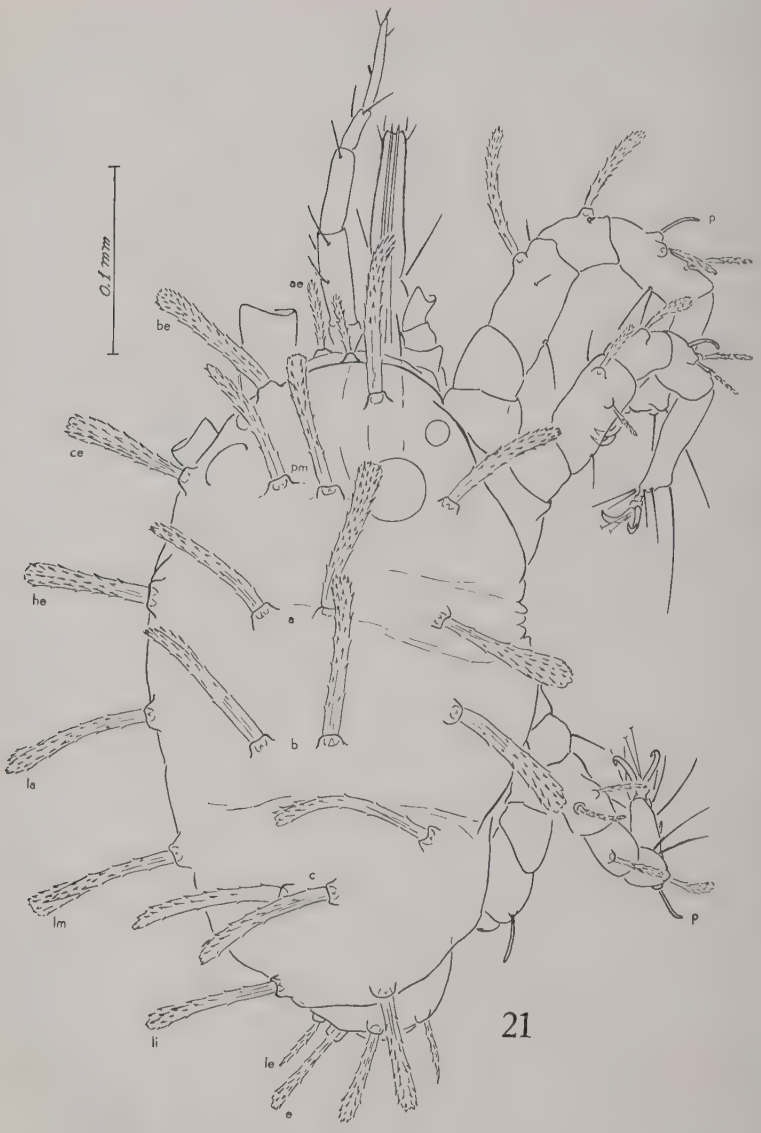

Plate VI

Exothorhis armata. Fig. 21, dorsal view of female with legs folded and right palp omitted.

Exothorhis armata new species

(Fig. 21)

FEMALE.—A comparatively large, armored species. Cheliceral stylets 118μ long, equal to length of slender rostrum. Palptibia with 2 acicular setae, no vestige of claw. Dorsal skeleton an almost continuous sheath or cuirass, with imperfect transverse folds which may or may not represent true sulci; its surface minutely punctate or alveolate. Humeral platelets integral with general skeleton; humeral setae *hc* possibly represented by first pair lateral hysterosomals. Eyes: 2 pairs; anterior pair normal, posterior pair large, prominent. Dorsal setae unique, heavy clubs, cylindrical near bases, flattening near tips to spatula shape; coarsely denticulate; each with prominent tubercle; all subequal except verticals, suranals. Dorsal setae on femora, genua, tibiae similarly fashioned. Middle pair ventral podosomal setae at least 90μ long, their alveoli peculiarly close together (8μ). Tibia I possesses only 5 bristles (solenidion *p*, 2 spatulate setae, 2 acicular setae); distal solenidion *dt* absent. Measurements in microns: idiosoma, vertical setae to anus, 375; greatest width, 200; preocular seta *be*, 79; intercalary seta *li*, 71; dorsomedian seta *c*, 80.

MALE.—Not known.

HOLOTYPE.—Female, Australia, intercepted at Hawaii, Aug. 6, 1954 (L. M. Chilson), *ex* cuttings of *Macadamia* sp., Lot 54-10280. In the collection of the United States National Museum.

The species is readily identified by its heavy, spatulate setae, complete investment of dorsum by skeleton, absence of a claw on palptibia, and absence of solenidion *dt* on tibia I.

Saniosulus new genus

Idiosoma elongate, fusiform; no dorsal plate armature except for a pair of small, ill-defined plates between the eyes and a narrow suranal plate over tip of opisthosoma.

TYPE SPECIES: *Saniosulus nudus* new species.

There is a resemblance between the genera *Saniosulus* (Eupalopsellidae) and *Apostigmaeus* Grandjean (Stigmaeidae). Both genera contain long-bodied forms having only small areas of the idiosoma covered with identifiable plates, nondescript dorsal setae, similar positioning of legs, and some points of close similarity in leg chaetotaxy. In the present state of taxonomic organization of the Superfamily Raphignathoidea, the two genera fall into separate families.

Saniosulus nudus new species

(Fig. 22)

FEMALE.—Gnathosoma short, less than one-third length idiosoma, its appendages not attenuate. Palpfemur twice as long as genu; genu and tibia short segments with length slightly greater than their diameters; tibia with stout, curved claw plus one minute spine-like seta close beside its longer dorsal seta; palptarsus moderately developed, its overall length barely exceeds tibia plus claw. Setae on palp segments: femur 2, genu 1, tibia 3, tarsus 7. Anterior pair ventral gnathosomal setae 11μ apart, on rostrum; posterior pair 33μ apart on maxillicoxae. Idiosoma pyriform,

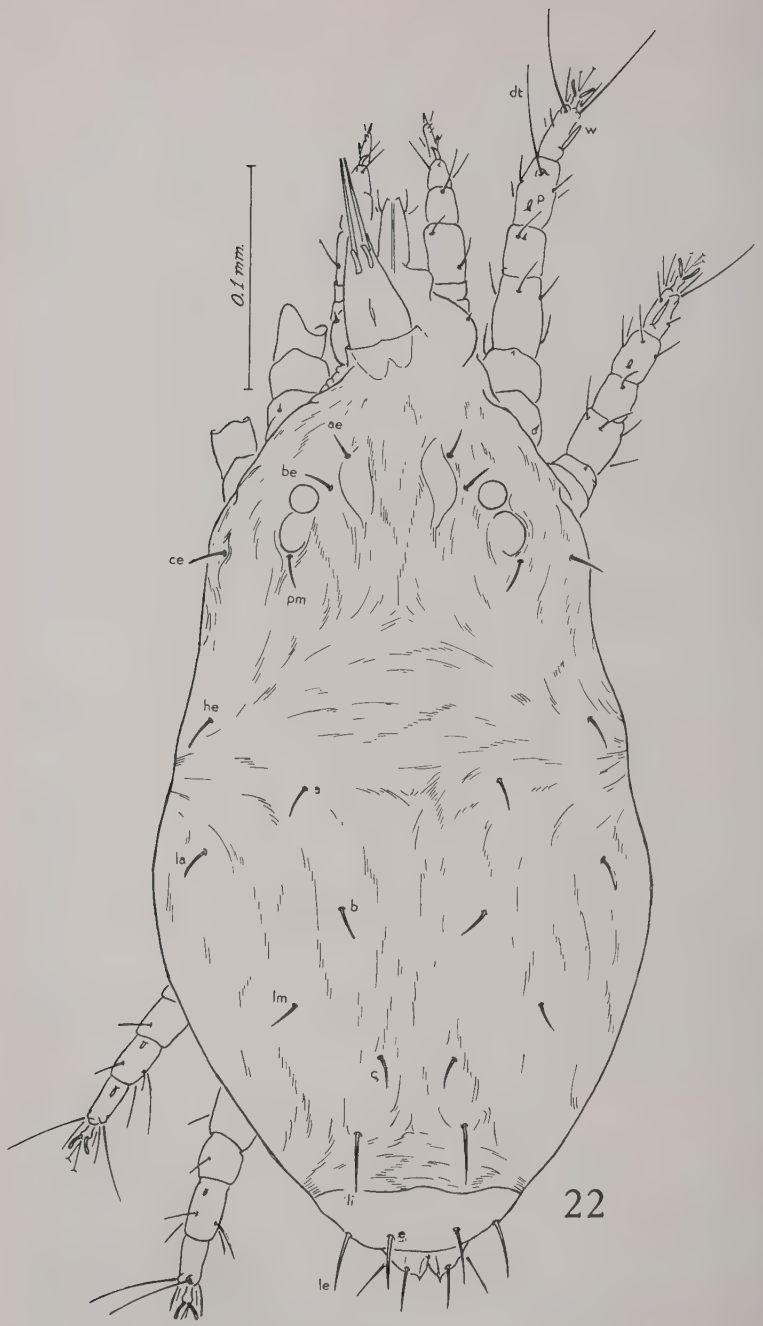

Plate VII

Saniosulus nudus. Fig. 22, female, dorsal aspect.

elongate, slightly constricted in mid-section, with coxal groups widely separated; demarcation between propodosoma, hysterosoma indicated by transverse striae across mid-section of idiosoma, considerably behind propodosomal setae. Two pairs eyes. Dorsum without definable plates except for one pair of small, non-striated, comma-shaped areas on propodosoma between first 2 pairs setae, and one small suranal plate. Setae of dorsum finely denticulate; 10 pairs very short, subequal; 3 pairs on posterior opisthosoma longer than others; posterior dorsomedians *pm* on propodosoma widely spaced, each seta displaced laterally to postocular position; postocular setae *ce* in marginal position; humeral setae *he* displaced backwards and in line with lateral hysterosomals. Venter without plate structures except ano-genital covers; genital, anal setae normal for family. Ventral setae of podosoma very long, flagelliform; anterior pair at least 80μ long, 41μ apart; middle pair at least 72μ long, 95μ apart; posterior pair at least 45μ long, 60μ apart. Inclusive counts of setae and sensilla on podomeres of legs I-IV: femora 4-4-2-2, genua 2-1-1-1, tibiae 6-5-5-5, tarsi 11-9-7-6. Solenidion *w* on tarsi I-II inflated, tapered from base to tip, its length equal to diameter of tarsus; this sensillum reduced to a tiny peg on tarsus III, absent on IV. Solenidion *p* on tibiae I-IV diminutive, bullet-shaped, slightly longer than its own diameter. Measurements in microns (1 specimen): idiosoma, vertical setae to anus, 378; greatest width, 230; leg I, 155; preocular seta *be*, 14; intercalary seta *li*, 27; dorsomedian seta *c*, 15.

Male.—Not known.

Holotype.—Female, Mexico, intercepted at Brownsville, Texas, Sept. 22, 1952 (Anon.), *ex* orchid plants, lot 52-10595. In the collection of the United States National Museum. Paratype ♀, Valverde, Texas, Oct. 6, 1953 (H. A. Dean), *ex* orange leaf with diaspid scale, USNM.

The spot characters are: elongation of idiosoma, absence of extensive dorsal plates, extremely short dorsal setae, and wide spacing of dorsomedian setae *pm* on propodosoma. The occurrence of a substantial palp claw and the diminutive solenidion *p* on tibia I are helpful combination characters.

Two pairs of dorsal setae on *S. nudus* intrude a question of homology. The posterior dorsomedians *pm* of other eupalopsellids are not similarly located in *S. nudus*. But since the species otherwise conforms with the characters of the family, it is supposed that its setae of the pair *pm* are displaced laterally to the usual postocular position and that the homologues of the true postoculars *ce* are located in a more marginal position than usual. The humerals *he* in this case seem to be placed near the mid-section of the body, in series with the dorsolaterals of the hysterosoma. The identification of these setae as humerals *he* indicated in fig. 22, is supported by the fact that the transverse striae converge behind the setae of this pair. The transverse girdle of striae is taken to be the demarcation between propodosoma and hysterosoma.

Acknowledgments

Three of the new species included in this study were identified in a collection of slides loaned by the United States National Museum through the courtesy of Dr. E. W. Baker. This is to thank Dr. Baker for selecting the specimens and the Museum for lending them.

Dr. M. H. Muma, University of Florida Citrus Experiment Station, generously provided sufficient material to describe *Exothorhis caudata*. Another new species, *Eupalopsis acus*, was found among specimens contributed by Dr. D. A. Chant, Canada Department of Agriculture. Dr. G. F. Knowlton and his associates sent numerous collections of specimens from Utah. Many thanks also to these gentlemen.

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SUPPRESSION OF THE GENUS *ROPLISA* CASEY WITH NOTES ON THE UNITED STATES SPECIES OF *TRIGONOPELTASTES* BURMEISTER (COLEOPTERA: SCARABAEIDAE)[1]

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The genus *Roplisa* was created in 1909 by Thomas Casey to receive a unique new species *R. floridana* (Casey, 1909, p. 284). At the time of the original description, Casey had only two specimens before him which were merely labeled "Florida." When he reviewed the North American Cetoniinae (Casey, 1915), he listed no additional specimens and redescribed the types. Blatchley (1928), in his Scarabaeidae of Florida, merely repeated Casey's description and reported no additional records. No records of this species, other than the types, have been published for 50 years, even though a few specimens have been collected during that period. This insect has long been considered one of the rarest of the United States Scarabaeidae.

The writer, after finding a single specimen of this species in a spider web at Juniper Springs in the Ocala National Forest, Marion County, Florida on July 12, 1959, began an immediate search of the vicinity. Twenty-eight additional specimens from the blooms of the scrub-palmetto, *Sabal etonia*, were collected with the help of Mr. H. A. Denmark. As many as 12 individuals were collected from the blooms of a single plant although few plants were found blooming. This series represented more than the total number of specimens (16) known at that time.

When this series and additional specimens were studied in detail, several errors were apparent in Casey's original description. It was also discovered that the male was undescribed and differed considerably from the female.

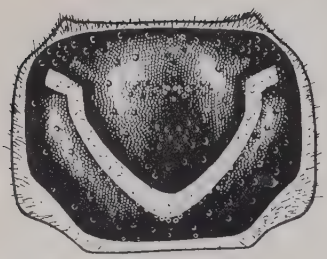
Trigonopeltastes floridana (Casey) new combination

Roplisa floridana Casey, 1909, p. 284; 1915, p. 379-380; Blatchley, 1930, p. 32.

Casey separated the genus *Roplisa* from *Trigonopeltastes* by the number of antennal segments and the relative length of the posterior tibiae and tarsi. He states (Casey, 1909, p. 284) that the antennae are "9-jointed" in contrast to the "10-jointed" antennae of *Trigonopeltastes*. The types[2] are females and have 9-segmented antennae. However, all of the male specimens examined had 10-segmented antennae. Twenty-two females were examined; 6 specimens had 10-segmented antennae, 13 specimens had 9-segmented antennae, and 3 specimens had 9 segments on one side and 10 segments on the other. Although the majority of females apparently have 9-segmented antennae, this character is too variable to be considered of prime importance in a generic separation. He also states (Casey, 1909,

[1] Contribution No. 9, Entomology Department, State Plant Board of Florida.

[2] The writer is indebted to Mr. O. L. Cartwright, U. S. National Museum, for information concerning the Casey types and for additional records.



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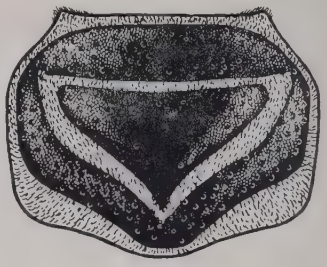

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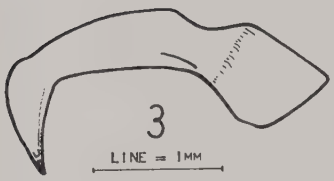

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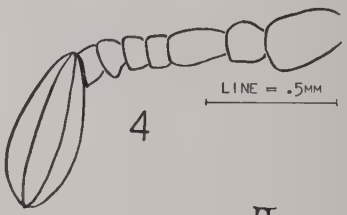

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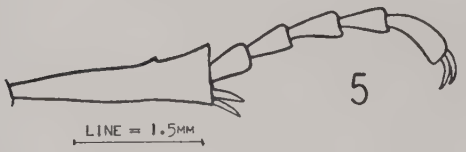

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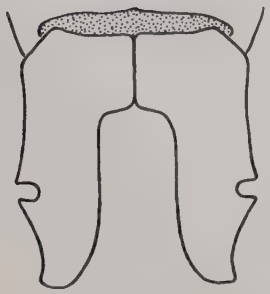

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PLATE I

p. 284) that the . . . "posterior (tarsi) being not longer than the tibiae." Apparently he reexamined the specimens for his description 6 years later, for he states (Casey, 1915, p. 380) "hind tarsi barely longer than the tibiae." Measurements of 32 specimens indicate the posterior tarsi are always longer than the posterior tibiae. In the males, the tarsi are nearly a millimeter longer, whereas in the female they average ½ millimeter longer than the tibiae. Casey (1915, p. 380) states that " . . . I do not know the sex of the two at hand, although it might be inferred that they are males. . . . " The types are actually females and therefore the male is undescribed.

Since both of these characters (i. e. number of antennal segments and relative length of posterior, tibiae and tarsi) are used by Casey to establish his genus *Roplisa*, there seems little justification for retaining this name. The name *Roplisa* Casey, 1909, is herewith relegated to synonymy with *Trigonopeltastes* Burmeister, 1840.

The genus *Trigonopeltastes* as now defined is strictly American and contains 10 described species. In addition to the 2 United States species, there are 7 species in Central America ranging from Mexico to Panama and 1 described from Brazil.

The genus *Trigonopeltastes* is characterized among the Cetoniinae by having a deltoid impressed marking on the pronotum. In *T. delta* (Forst.), as in most species of the genus, this impression forms a completed triangle (Fig. 2). In *T. floridana* this marking is V-shaped (Fig. 1) with only a vestige of the front side of the triangle in the form of a line of a few dense punctures. This line is more pronounced in some specimens than in others. This type of marking also occurs in some of the Central American species. The deltoid impression, as well as the entire impressed border of the pronotum, is filled with a bright golden tomentum in *T. delta* (Forst.). This same area is white or cream colored in *T. floridana* (Casey). The genitalia are quite distinct but of the same general type (Figs. 6 and 7). Although *T. delta* (Forst.) and *T. floridana* (Casey) are similar in general appearance, they are abundantly distinct in specific characters.

KEY TO THE UNITED STATES SPECIES OF *Trigonopeltastes* BURM.

1. Impressed pronotal marking in the form of a completed triangle (Fig. 2), tomentum golden yellow; pronotal surface dull, not shining in either sex; anterior tibia bidentate in female and tridentate in male; antennae 10-segmented in both sexes; genitalia as in Fig. 6; Southeastern United States ..... *delta* (Forst.).

1′ Impressed pronotal marking in the form of a V-shaped area (Fig. 1) filled with a whitish or yellowish tomentum; pronotal surface shining in

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LEGEND FOR PLATE I

Fig. 1. Pronotum of female *Trigonopeltastes floridana.*
Fig. 2. Pronotum of female *Trigonopeltastes delta.*
Fig. 3. Lateral view of male genitalia of *T. floridana.*
Fig. 4. Antenna of female *T. floridana* (from a slide preparation).
Fig. 5. Posterior tibia and tarsus of *T. floridana.*
Fig. 6. Caudal view male genitalia *T. delta.*
Fig. 7. Caudal view male genitalia *T. floridana* (allotype).
Fig. 8. Posterior tibia and tarsus of *T. delta.*

female and velvety in male; antennae 10-segmented in male, and either 9- or 10-segmented in female; anterior tibia bidentate in both sexes; genitalia as in Fig. 7; peninsular Florida.....*floridana* (Casey).

DESCRIPTION: Female *Roplisa floridana* (Casey). Similar in general appearance and shape to *T. delta* (Forst.); body narrow, oblong-oval, slightly convex; color somewhat variable but normally with black and orange-red markings broken by yellowish areas of tomentum, pattern quite similar to that of *T. sallei* Bates of Mexico.

Head black, shining, irregularly punctato-rugose; clypeus punctate medially, longitudinally rugose laterally, nearly as long as wide, parallel and rounded at the side, thickened, broadly, feebly arcuate, with rounded angles and feebly sinuate medially at apex; eyes emarginate, not large; antennae rufotestaceous, 9- or 10-segmented, club oval and 3-segmented (Fig. 4).

Pronotum black, shining, slightly wider than long, sides nearly parallel, anterior ⅓ sinuate, front angles projected to a point, anterior margin broadly concave, hind angles rounded after arcuate posterior ⅓, making base broadly lobed. The surface irregularly punctate, broadly open V-shaped impressed line heavily sculptured and filled with yellowish tomentum. Occasionally a dense line of punctures will tend to reproduce the markings of *T. delta* and to close the anterior portions of the V-shaped impression. However, this line is never filled with tomentum. Entire pronotal border slightly depressed and filled with yellowish tomentum similar to that of the V-shaped marking and becoming broader at the posterior pronotal angles (Fig. 1).

Elytra longer than wide, only little wider than pronotum, sides subparallel and broadly arcuate, surface finely, in most part obsoletely punctate with a very few longitudinally incised lines, the posterior edge finely transversely rugose. Elytral markings irregular but with five areas of yellowish tomentum on each elytron, the elytral suture bordered by an elongate patch basally which is nearly continuous with the tomentose markings of the scutellum (reminiscent of quotation marks); at the posterior of these markings are two small elliptical markings at right angles to the suture, and two rounded areas of tomentum on the lateral border of each elytron, the anterior one being larger. Scutellum sparsely coarsely rugose, mostly covered by tomentum.

Pygidium convex, longer than wide, surface with bioblique and rather coarsely incised wavy lines, tomentose laterally and along the base, non-tomentose area black, shining.

Legs rufous, tarsi slightly longer than tibiae, claws not cleft. Middle and posterior tibiae each with two flattened spurs of unequal length, longer of the two slightly longer than first tarsal segment. Anterior tibiae broadly rounded with a single tooth slightly beyond the middle and the tibial apex prolonged into a pointed tooth opposite the single tibial spur which is longer than the first tarsal segment.

Ventral surface heavily sculptured with incised lines like those of the pygidium, with scattered areas of tomentum except medially and posteriorly.

The legs and body are often covered with a dense coating of pollen grains which tend to make the specimen seem totally tomentose.

ALLOTYPE:—Male, Juniper Springs, Ocala National Forest, Marion County, VII-12-59, R. E. Woodruff (author's collection). Length from anterior pronotal margin to base of pygidium 6 mm; greatest width 3.75 mm. Similar to female in general appearance and in most structures. The antennae are larger and longer; ventral surface more universally and heavily tomentose; pronotum and head dull, velvety, less densely punctate; anterior tibial spur shorter than first tarsal segment. Genital armature smaller than *T. delta* (Forst.) and generally similar to those of the genus *Trichiotinus*. Claspers nearly parallel on the outside margin and slightly bowed on the inner margin; lateral dentations very near the apex with the tips of the claspers truncate. The males are much less numerous than the females and very few specimens have been seen. In a series of 28 specimens collected at the same time, there were 24 females and 4 males.

VARIATION:—This species is relatively constant in all major morphological structures. Variation was noted primarily in size (length from anterior pronotal margin to base of pygidium 6.0 to 8.6 mm) and color markings on the elytra. Additional variation was noted in the extent and denseness of punctures on the pronotum (especially at the anterior portion of the V-shaped impression). The lateral tooth of the anterior tibiae is more pronounced in some specimens than in others, generally an indication of wear. The extensiveness of the dense tomentum is quite variable but much more pronounced in the males. However, this tomentum can be easily rubbed off if specimens are not properly handled. A single male specimen was examined which had practically no orange or reddish markings on the elytra. The color pattern consisted almost entirely of a contrasting black with yellow tomentum. This specimen agreed in all morphological characters with other specimens examined.

ECOLOGY:—In 1958, the writer saw two specimens of this species from the Archbold Biological Station, Highlands County, Florida (listed below), bearing the labels "at blooms of saw-palmetto." Since this was the only known reference to the ecology of this species, the writer made a special search on this plant to obtain additional specimens. The saw-palmetto (*Serenoa repens*) is very abundant in Florida and literally hundreds of blooms were examined for this beetle. No additional specimens have been found on this plant. Since *Sabal etonia* is quite similar in appearance to *Serenoa repens* and since they occur in the same locality, the writer suspects that the specimens referred to above were actually collected on *Sabal etonia*. The blooms of this species are more fragrant and much more attractive to other insects than are those of *Serenoa repens*. The scarcity of this beetle even in Florida collections leads the writer to believe that this species is rather host specific and occurs in a restricted ecological niche.

The scrub-palmetto (*Sabal etonia*) is rather characteristic of certain areas in Florida known as "scrub" (Small, 1925). This plant is similar in general appearance to the young stage of the cabbage palmetto (*Sabal palmetto*) and to mature plants of the saw-palmetto (*Serenoa repens*). It is an endemic species which is rapidly becoming rare. Small (1925, p. 147) says "if, however, the species is not tending toward extermination through natural conditions and enemies, then the white man is doing his part to exterminate it, not only in the clearing of land generally, but in removing the esculent bud for food. . . . "

This plant occurs on two entirely different geological formations which are unlike in their plant associations. One of these formations is the oolitic limestone of the Everglades and Keys and which supports a flora similar to that of the West Indies. The other is a loose sand characteristic of several areas of peninsular Florida which harbors many rare and endemic plants and animals. Laessle (1958) has discussed some of the scrub areas in the Ocala National Forest.

The blooms of *Sabal etonia* bend near the ground and are difficult to see, as they are whitish and tend to blend with the white sand background of the plants. They are extremely fragrant and attractive to a wide variety of insects.

DISTRIBUTION:—The following specimens were examined during the course of this study: 1 ♀, Florida, Marion County, Ocala National Forest, R26E, T17S, Section 10 and 15, VI-10-38, T. H. Hubbell (University of Michigan, Museum of Zoology); 1 ♀, Florida, Gainesville, VI-24-40, F. N. Young, flying in afternoon (UMMZ); 1 ♀, Florida, Winter Park, VII-16-38, H. T. Fernald (State Plant Board of Florida); 3 ♂♂, Florida, Vero Beach, VII-4-32, E. M. Becton (SPBF); 1 ♀ and 1 ♂, Florida, Highlands County, Archbold Biological Station, VI-16-55, H. Dybas, at blooms of saw-palmetto, *Serenoa repens* (Chicago Natural History Museum); 1 ♀, loc. cit. (Henry Howden); 23 ♀♀, 3 ♂♂, Florida, Marion County, Ocala National Forest, Juniper Springs, VII-12-59, R. E. Woodruff, at blooms of *Sabal etonia* (R. E. Woodruff); 2 ♀♀, loc. cit., H. A. Denmark (SPBF).

In addition to the above records, Mr. O. L. Cartwright supplied the following data on specimens in the U. S. National Museum: Holotype ♀, Florida; paratype ♀, Florida; 1 ♂, Florida; 1♀, Florida; 1♂, Orlando; 1 ♂, Winter Park; 1 ♂, Ocala National Forest.

Trigonopeltastes delta (Forst.)

This species is widely distributed in the southeastern United States and has been recorded from Ohio to Florida and west to Texas and Arkansas. It is a very common species in Florida and has been found on a variety of flowers, including the following: *Codiaeum variegatum* Blume (croton bud), *Hibiscus rosa-sinensis* L. (hibiscus), *Rosa* sp. (rose), *Rhus leucantha* Jacq. (southern sumac), *Mangifera indica* L. (mango), *Thuja* sp. (arborvitae), *Ligustrum japonicum* Thunb. (privet), *Severinia buxifolia* Ten. (boxthorn), *Ceiba pentandra* Gaertn. ("kapok"), *Persea americana* Mill. (avocado), *Sabal palmetto* Lodd. (cabbage palm), *Litchi chinensis* Sonner (lychee), *Vanda* sp. (orchid), *Crotalaria* sp. (crotalaria), *Quercus muehlenbergii* Engelm. (chinkapin oak), *Citrus* sp., *Magnolia* sp. (bay), *Dianthus* sp. (carnation), *Euphorbia* sp. (poinsettia), *Cephalanthus occidentalis* L. (button-wood), *Senecio* sp. (groundsel), *Ipomoea* sp. (morning glory), *Zizyphus* sp. (jujube), *Schinus* sp. (Brazilian pepper), *Casimiroa edulis* L. & L. (white sapota), *Cyrilla racemiflora* L. (leatherwood), *Elephantopus elatus* Bertol (elephant-foot), *Daucus carota* L. (cultivated carrot), *Ilex glabra* Gray (inkberry), *Rhus copallinum* L. (shining sumac), *Lachnanthes tinctoria* (Walt.) Ell. (red-root) and *Ceanothus americana* L. (New Jersey tea).

It has also been collected in Japanese beetle traps (using geraniol and eugenol) and fruitfly traps (using angelica oil and sweet baits). Blatchley (1930, p. 33) also records specimens collected at light.

Variation in this species parallels that of *T. floridana* (Casey). There is considerable variation in the shape and distribution of the color pattern on the elytra, but these variations have not been found to be correlated with any differences in genitalia.

The sex of this species can be determined readily since the male has bidentate anterior tibiae while the female has the same structure tridentate; the male posterior femur is more greatly swollen and twisted than that of the female; the male pronotum is duller, more velvety (as in *T. floridana*), and less densely punctate than that of the female. The males seem to be about three times more abundant than the females (this ratio is reversed in *T. floridana*).

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THE NEOTROPICAL MILLIPEDS IN FLORIDA, INCLUDING *CALYPTODESMUS SCHUBARTI*, N. SP. (STYLODESMIDAE: POLYDESMIDA)

NELL B. CAUSEY
Fayetteville, Arkansas

The 4 species of Neotropical millipeds that have been collected in Florida represent 4 of a total of 32 genera that are known in the state. There may be others that have been overlooked, for millipeds have not been collected intensively there. The Neotropical species are all small-bodied forms 7 mm. or less in length that are collected either with a Berlese funnel or by careful examination of the lower surface of logs and boards. Most of the microdiplopods that appear in Berlese collections are larval forms, but even larvae can be of taxonomic value if they have specifically characteristic surface sculpture, as in the family Stylodesmidae.

The only colobognath milliped that has been collected in southern Florida is *Siphonotus purpureus* Pocock, an introduced Neotropical species that extends through most of the Lesser Antilles and Hispaniola to the northern coast of South America (Chamberlin and Hoffman, 1958). It is well established in southern Florida, often occurring in cultivated areas with two introduced polydesmids, *Oxidus gracilis* (Koch) and *Orthamorpha coarctata* (Saussure). These polydesmids are tropicopolitan and do not come within the scope of this paper.

The other three Neotropical millipeds in Florida are polydesmids that represent three genera of the large, widespread tropical family Stylodesmidae. *Lophodesmus caraibianus* (Chamberlin, 1918) has been collected from under a board in Miami by Mr. Robert E. Woodruff, entomologist of the Florida State Plant Board. This species has long been known from Nassau and Haiti (Loomis, 1936). *Psochodesmus crescentis* Cook, 1895, the most abundant micropolydesmid on the Florida peninsula, occurs from Putnam County to the end of the peninsula. It is well established in rural areas. *Calyptodesmus schubarti*, n. sp., has been collected once from under a board in Columbia County; this site approaches the northern limit of the range of the family Stylodesmidae. The last two species have not been collected outside Florida, but their affinities are so clearly with the Neotropical fauna they cannot be regarded as indigenous to Florida.

The only other members of the family Stylodesmidae that are known in the United States are two species of the genus *Ilyma* from the Louisiana-Texas coastal area (Loomis, 1959); they also are small-bodied forms and are included in the key below.

KEY TO THE FAMILY STYLODESMIDAE IN THE UNITED STATES

1. With repugnatorial pores on segments 5, 7, 10, 13, and 16 . . . 2
   With repugnatorial pores placed otherwise 3

2. Segment 19 with the posterior processes extending much beyond the apex of segment 20 . . . . . *Ilyma cajuni*

   Segment 19 with the posterior processes shorter, extending only to the apex of segment 20 . . . . . *Ilyma digitata*

3. With repugnatorial pores on segments 5, 7, 9, 10, 12, 13, 15, and 16 . . . . . *Lophodesmus caraibianus*

   With repugnatorial pores on segments 5, 7, 9, 10, 12, 13, and 15 . . 4

4. All nonporiferous segments with either 3 or 4 lateral lobes on the paranota . . . . . *Psochodesmus crescentis*

   All nonporiferous segments except segment 2 with 2 lateral lobes on the paranota . . . . . *Calyptodesmus schubarti*, n. sp.

GENUS *Calyptodesmus* SCHUBART

Calyptodesmus Schubart, 1944, Acta Zool. Lilloana, vol. 2, p. 367.
Generotype: *C. sancta* Schubart 1944.
Range: São Paulo and Florida.
Species: Two.

DIAGNOSIS: Pores on segments 5, 7, 9, 10, 12, 13, and 15. Pore stalks project from below the middle lobes. Lateral margin of all nonporiferous paranota except segment 2 divided into 2 lobes. Margin of anal tergite divided into 7 lobes, of which the middle one is the broadest. Gonopods unknown.

Calyptodesmus schubarti, new species

(Figure 1)

DIAGNOSIS: Distinguished from *C. sancta* by the 3 solitary tubercles on the caudal margin of metatergites 2 through 17 between the 4 longitudinal crests of primary tubercles. The 4 vertical rows of granules on the vertex also may be a specific character.

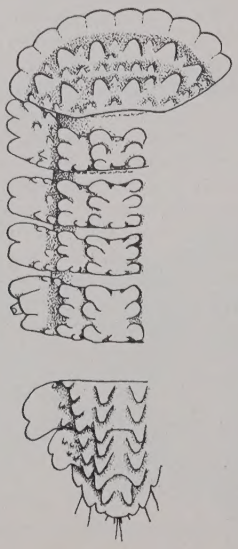

Figure 1. Dorsal surface of *Calyptodesmus schubarti*, n. sp., showing the entire collum and parts of segments 2 through 5 and 18 through 20.

TYPE LOCALITY: Lake City, Columbia County, Florida, 12 ♀, June 12, 1959, N. Causey.

RANGE: Columbia and Alachua Counties, Florida.

DEPOSITION OF TYPE MATERIAL: Female holotype, American Museum of Natural History; female paratypes, Florida State Plant Board, U. S. National Museum, and the author's collection.

DESCRIPTION OF FEMALE HOLOTYPE: Length 5 mm., greatest width 0.7 mm. Color light tan; under magnification irregular red spots can be seen on the paranota. Dorsum strongly arched. Paranota low and almost horizontal; on segments 2 through 5 they are bent slightly cephalad; on segments 18 and 19 they are bent slightly caudad; on the remaining segments they are directed laterad.

Vertex of head covered with granules, the largest of them arranged in 4 subvertical single series. Antennae short, thick, geniculate, the fifth segment longest and widest, and the fifth and sixth segments each with a setose sensory area on the distal margin.

Collum large and dome-shaped, completely hiding the head from above. Its anterior margin is horizontal and divided into 10 equal, deeply incised lobes; indistinct radii extend between the lobes. Dome of collum with 10 large, rounded tubercles arranged in 2 curved series of 6 and 4 and between and around them about 20 smaller tubercles. Metatergites 2 through 19 with 4 longitudinal crests composed of large, rounded, subequal tubercles, equally spaced horizontally, and in groups of 3 on each metatergite. Three secondary tubercles are on the caudal margin of metatergites 2 through 17 between the longitudinal crests. Several secondary tubercles, usually from 5 to 8, are arranged in 3 transverse series on each paranotum. Last segment with 2 large tubercles.

Lateral margin of segment 2 divided into 3 equal, deeply incised lobes. Lateral margin of all other nonporiferous segments divided into 2 lobes; on the anterior segments they are equal and deeply incised; on the posterior segments the anterior lobe is much the larger. Lateral margin of all poriferous segments divided into 3 subequal lobes; the pore stalks project from below the middle lobes and make them inconspicuous; on the more posterior segments the third lobe does not extend as far laterad as the first one. Margin of segment 20 divided into 7 not very unequal lobes; the incisions between the middle 3 lobes are shallow and easily overlooked.

This species closely resembles *Psochodesmus crescentis* in size, color, and shape, but its longitudinal crests are more distinct and the remainder of the dorsum is not as rough.

I am grateful to Mr. H. F. Loomis for specimens of *Lophodesmus caraibianus* from Haiti.

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ADDENDUM

Since this paper went to press the following records of the family Stylodesmidae in Florida and nearby states have been added:

Calyptodesmus schubarti, Hogtown Creek Area, Gainesville, Alachua County, Florida, 1 ♀ larva, Oct. 10, 1959, Wm. J. Platt, III.

Psochodesmus crescentis, Lower Matacumbe Key, Monroe County, Florida, 1 ♀ larva, Dec. 16, 1959, R. E. Woodruff.

An undescribed species of the genus *Ilyma*, 1 ♀ and 2 larvae, George County, Mississippi, and Baldwin County, Alabama, N. Causey.

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